THE GLASS INDUSTRY

VOLUME 31, NUMBER 12, DECEMBER, 1950

CONTAINER GLASS COMPOSITIONS—1949

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Abstract

This is the fourth in a series of annual reports on the trends in container glass compositions[1, 2, 3]. The data presented in this report are based on chemical analyses and other tests of glass from 65 furnaces. Of this number, 46 are flint, 12 amber, and 7 green. The average composition and properties are compared with the 1948 glasses. Graphs showing the distribution of the precentage of each oxide are shown.

Comparison of 1948 and 1949 Glasses

The average composition and physical properties of glasses produced in 1949, and comparisons with 1948, are presented in Table I.

TABLE I

Average of Container Glass Compositions

Oxide	*1948*	*1949*	*Difference*
SiO_2	72.6%	72.0%	— 0.6
R_2O_3 (Al_2O_3 + Fe_2O_3) .	1.80	2.06	+ 0.26
CaO + MgO.....	10.03	10.25	+ 0.23
Na_2O + K_2O.....	14.83	14.92	+ 0.09
Minor constituents	0.83	0.77	— 0.06

The average quantities of minor constituents are listed in Table II. Averages are based on the number of glasses containing more than a defined trace of the particular constituent.

Average figures for physical properties are listed in Table III.

Discussion

Distribution charts (Figs. 1 to 8) for the most common constituents, provide an interesting picture of the range for the individual oxides.

Silica, Fig. 1, is found most commonly between 72% and 74%, with no glasses containing more than 74% and only a few less than 72%. Last year (1948), about 13 per cent of the glasses contained over 74% silica. Because of the discontinuation of high silica glasses in 1949, the average amount of silica decreased by more than 0.5%.

Fig. 2 shows a continuation in the use of the alumina in amounts between 1.0 and 2.5, with the majority of the glasses containing 1.5 — 2.0%. Some special glasses

TABLE II

Average of the Minor Constituents

Oxide	*1948*	*1949*	*Difference*
BaO	0.41%	0.43%	+ 0.02
B_2O_3	0.37	0.33	— 0.04
SO_3 (Flint Glasses) ...	0.23	0.24	+ 0.01
S (Amber Glasses)....	0.03	0.04	+ 0.01
F_2	0.20	0.20	0
Fe_2O_3 (Flint Glasses)..	0.055	0.051	— 0.004
Fe_2O_3 (Amber Glasses)	—	0.15	0

TABLE III

Average Physical Properties

Physical Properties	*1948*	*1949*	*Difference*
Softness Temperature °C..	710	712	+ 2
Annealing Point °C.....	521	527	+ 6
Strain Point °C.....	488	495	+ 7
Thermal Expansion x 10^7/°C	89.3	90.0	+ 0.7
Homogeneity (ring section)	B —	B	+ ½ grade
Seed Count (bubbles/oz. weight)	25	25	0

[1]Container Glass Compositions 1932-1946, H. Moore & A. K. Lyle—The Glass Industry 28, 11 (563-566) Nov. 1947.
[2]Container Glass Compositions 1947, A. G. Allen & A. K. Lyle—The Glass Industry 29, 9 (493-494) Sept. 1948.
[3]Container Glass Compositions—1948, P. A. Webster & H. Moore—The Glass Industry 30, 12 (657-659) Dec. 1949.

produced on the West Coast contain as much as 10.0% alumina.

Total line plus magnesia, Fig. 3, is found most commonly in the range of 10 — 11%, with an average of 10.2%. The 1949 distribution is generally similar to 1948 and the average is nearly the same.

The total sodium plus potassium oxides, Fig. 4, is most commonly used in amounts between 14 and 15%. Although the average alkali content, 14.9%, is the same as in 1948, fewer glasses contain over 15 per cent. The trend towards lower alkali is being continued, even though there was no shortage of soda ash such as influenced the compositions of 1946 and 1947.

Barium oxide, Fig. 5, in amounts greater than 0.05%, is found in 70 per cent of the 1949 glasses. This constituent occurs most commonly in the 0.5 — to — 0.6% range, showing an increase of 0.1 per cent over 1948. However, barium is found in 10 per cent fewer glasses in 1949 than in 1948.

Boric oxide, Fig. 6, in amounts greater than 0.05%, is found in 32 per cent of the glasses, a decrease of 10 per cent over last year. This follows a trend evident over the past three years.

Fluorine, Fig. 7, in amounts greater than 0.02%, was

(*Continued on page* 652)

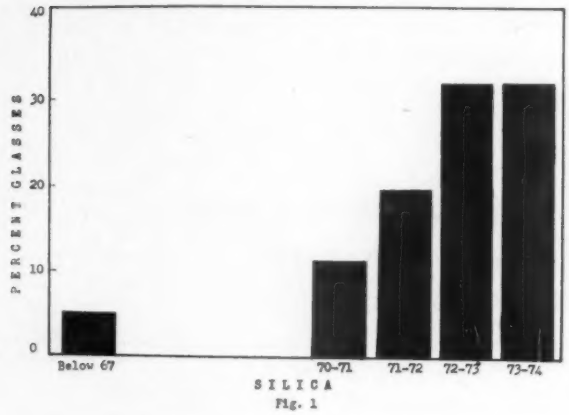


Fig. 1

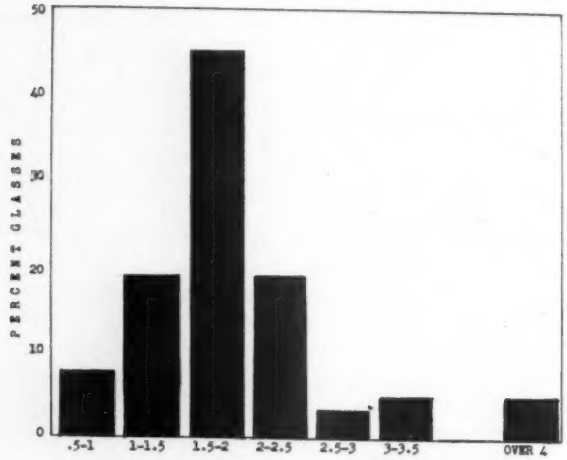


Fig. 2

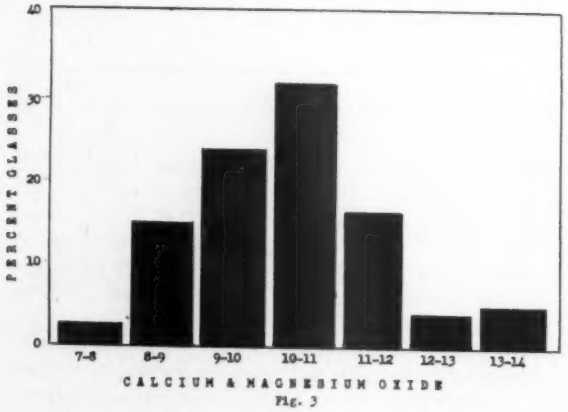


Fig. 3

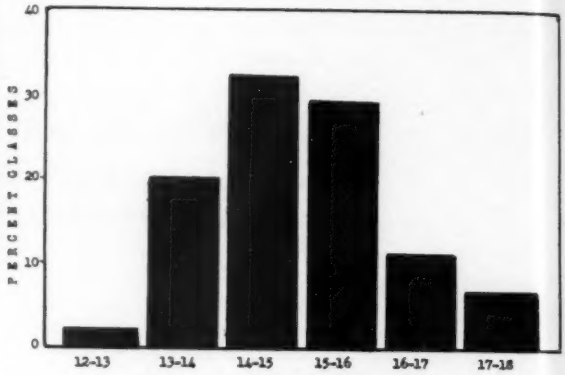


Fig. 4

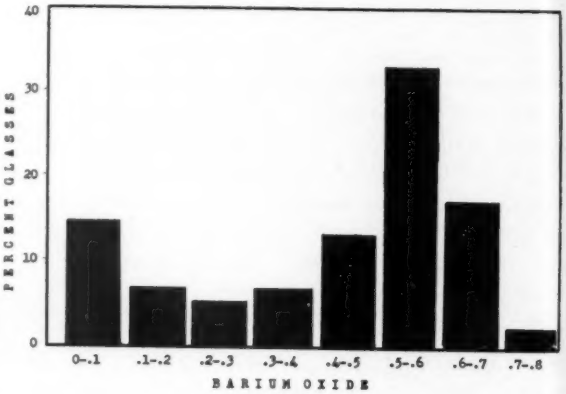


Fig. 5

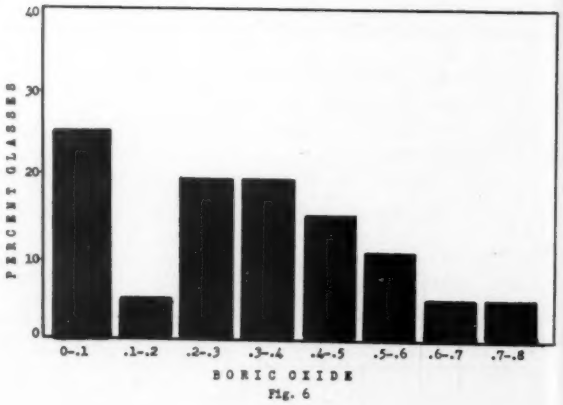


Fig. 6

OPTICAL SOCIETY MEETING INVESTIGATES SYNTHETIC CRYSTALS

A Symposium on Crystals, a feature of the Optical Society of America meeting held October 26, 27, and 28, revealed to what extent the search for piezoelectric detectors has procured crystalline optical materials which compete with or supplement glass. The growth of crystals in man-devised processes of laboratory and factory also provides general scientific as well as esthetical satisfaction.

The greatest single stimulus to the growth of crystals from solutions came from the shortage of South American quartz in Germany during the last war. The subsequent study of the growth of quartz which culminates in the recent successes of the Brush Development Company of Cleveland was preceded by a more general survey by Dr. B. Kjellgren.

Dr. Kjellgren described the meticulous care required in the control of the acidity of the solution, the temperature, the stirring speed, the shape of the seed—which is the starting crystal upon which is deposited the array of growth causing the final crystal to exist—, the anchoring of the seed, and, last but not least, the gentle rocking which is essential for uniform growth. This holds for all types of crystals now grown from solutions.

He then presented Dr. Hale, who indulged in the fascinating problem of the growth of synthetic quartz. The present stage of this enterprise can be called moderately successful. Small crystals, excellent for electrical and fair for optical purposes, can be made at will. This includes the control of twinning, the feared disease of monocrystalline growth. The mother liquid is an alkaline alkali silicate solution which is supersaturated at somewhat lower temperatures (350°C.) under high pressure (3000 psi) in the presence of natural seed plates. The growth appears to occur at rates which may be described as 200 mg/cm²/day or 2.10^{14} molecules/second/mm² or 1/2 mm/day on the specimens generally used. The most important control of twinning appears to be the exclusion of twinned seed material.

Abstracts of this and other papers of the crystal symposium were not available. Therefore, these and other remarks are the rather personal impressions of THE GLASS INDUSTRY's reviewer.

Dr. H. C. Kremers, of the Harshaw Chemical Company in Cleveland, added to the information he has been giving generally and generously to his chemical friends, in presenting to his new optical audience the present status of crystal growth from melts. The growing of fluorides by Harshaw is now common knowledge. Interesting comments were heard about other materials, the important bromides, as well as calcite and sodium nitrate. Ambitions about growing calcite were raised at times during the last war, but according to Dr. Kremers, new deposits of good natural calcite keep being discovered whenever the synthetic process gains momentum. This reviewer heard in the halls of this meeting that another interesting factor preventing the abundant industrial growth of some crystals is, at times, the ease with which they are procured from expanded laboratory facilities all around. Crystals from melts are grown in cylinders having a conical start. At the apex of the cone, according to Dr. Kremers, must take place the definite victory of one crystal growing center over its potential competitors. In the cone has to be overcome the dangerous space of irregular temperature gradients, while the final cylindrical part is relatively safe. The growth is guided as a deliberate gradient is imposed, starting at the point of the cone in one or another way. The crucible may be moved into a fixed gradient or may remain fixed in a changing gradient. The process is so delicate that the shape of the isolating jackets is rather important, and circular cross sections of jackets are now preferred.

Dr. H. Jaffee, also of Brush Development, discussed the more technical subject of optical applications of piezoelectric crystals, applications indirectly related to the piezoelectric effect. In the piezoelectric effect, pressure and electrical field are affected mutually. Dr. Jaffe studies the relation of the field to shifts in the propagation of light which affects the relations given by their natural birefringence. The effects are not usually great. In the ammonium phosphate type generally represented by ADP, however, a relatively excellent effect was obtained and "only" 9000 volts were required for what seems useful.

James H. Schulman, of the Navy Research Laboratory, reported on the effect of high energy radiation of the luminescent properties of crystals and glasses. When crystals are irradiated with high energy rays (X-rays, gamma rays, etc.) color and luminescence effects are observed which have been given various names by early workers in the field of radium research, especially Dr. K. Przibram, the discoverer of most of them. Dr. Schulman showed how crystals irradiated by gamma rays, when later irradiated by uv or other low energy rays, luminesce even though no luminescence was observed in the natural state. Discoloration may occur and is often an advanced stage of this induced luminescence ("radioluminescence"). The effect is attributed to simple and complex defects in the regular array of crystal forming ions, e.g. in the most simple case to one missing Cl^- between two Na^+ in a NaCl lattice. Examples, taken from the crystalline field, will well apply to the knowledge of luminescence properties of glass. This reviewer was assured that glass chemists may enjoy a paper by this author at a Glass Symposium to be organized at the Spring Meeting of the American Chemical Society.

Other papers in the symposium were of equal interest but are more technical from the viewpoint of the reader of this magazine. They were: C. D. West: "Polarizer, Polarizing Beam Splitter and Birefringent Elements"; H. D. Williams: "Growing Large Barium Titanate Crystals"; and A. De Bretteville: "The Properties of Large Barium Titanate Crystals."

Abstracts of all other papers than the preceding ones are to appear in the *Journal of the Optical Society of America.*

One series of these papers was also concerned with optical properties of crystals.

J. E. Jacobs of General Electric X-Ray Corporation, dealt specifically with cadmuim sulfide, which detects X

radiation in a mechanism pertaining to the family described by J. Schulman in the Symposium. When a secondary illumination of constant magnitude is applied to the crystal while it is X-irradiated, the characteristics of the crystal are greatly altered.

R. O. Carpenter reported his Harvard thesis dealing with detailed applications of induced birefringence as generally described in the above paper by Dr. Jaffe.

The optical properties of fluorides remain, in part, dependent upon individual procedures applied in their growth, although great progress has been made in the mastery of this problem. There is nothing, however, like a simple distinction between air and vacuum growth materials, as has been sometimes believed.

L. W. Tilton and E. K. Plyler, of the National Bureau of Standards, provided tables for indices, dispersions, and their temperature coefficients of LiF in the infrared region. Dr. S. Ballard, and his associates at Tufts College, presented an ample discussion of the variations in the optical properties of fluorides with their emphasis on purity rather than growing technique.

Dr. A. Smakula and M. Klein, of Ft. Belvoir, told of the dependence of polishing and grinding successes on the knowledge of the surface structure. These results are of great interest to glass people involved in the study of polishing surface chemistry as well as to those who consider the extension of their scope to optical crystal working.

THE GLASS INDUSTRY habitually reports on color activities as of major interest to some glass people. At the end of the color session, Eastman Kodak's Dr. D. L. McAdam, one of the leading color scientists, rose to ask: Should an American Revision of the ICI Colorimetry Data Be Proposed? He added a string of questions to this major one and stimulated quite some discussion.

The chief deviation of the present ICI system derives from errors as great as 1:10 in original evaluations of the sensitivity of the eye to short wave light.

The discussion of the experts, to this reviewer, indicated that at this moment because of lack of certainty on short wave characteristics of the eye, the fear of a revision after a revision prevails over that of prolongating the use of deviating data. Glass people will now continue to use ICI plots for their color work.

Among the many other papers, arbitrary mention is made of H. R. Davidson's fine tolerance study called "Visual Sensitivity to Surface Color Differences" in which samples obtained in his work for General Aniline & Film Corporation were compared visually and in McAdam elipses of equal perceptible color differences. Provided that the elipses are taken to mean differences larger than one (McAdam called them 1/3 least perceptible differences), good agreement was obtained. Visual sensitivity to "light-dark" variations was found much smaller (.1 Munsell value) than usual. However, the audience thought, in part, this may be due to a dyer's training to hue rather than to sensitivity proper. The excellent viewpoint of the paper, showing the increasing impact of the general views of the Color Council, is directly applicable to ceramic color problems including the field of glass.

Similarly, color specialists and enthusiasts in glass will continue to watch Miss Nickerson's studies. This time, she reported on color changes under artificial lighting. This is also the topic of I. H. Godlove's work. In his tables are charted typical shifts in color space due to artificial illumination of samples originally plotted from daylight data. This change works out well on these simple charts because the dyes have typical absorption bands. Since Dr. Hunter has successfully introduced his color difference meter to the ceramic industries, interest of glass technologists remains active in each new instrument. The Tristimulus Photometer by G. Sziklai was particularly adapted to the measurement of colored film.

Other sessions (about, and usually at least, half a dozen each) were devoted to: photographic exposure; photographic and related lenses; interferometry and phase contrast; spectrography; radio and pyrometry, including lamps and luminescence; illumination, including scattering and vision problems; light sources; infrared spectra and diffraction gratings. The optics sessions were introduced by a fundamental discourse by R. C. Jones of Polaroid Corporation.

The tendency in the art of ruling diffraction gratings is toward electronic and interferometric control and measurement methods as discussed in papers by George R. Harrison of M. I. T., Corwin Brumley and David Richardson of Bausch and Lomb, and David Humez of Jarrell-Ash. Methods for utilizing gratings of high resolution and efficiency were discussed by William G. Fastie of Leeds and Northrup and by Nisson A. Finkelstein of Bausch and Lomb. A paper describing the production of high quality replica gratings was given by Fred A. McNally and Richard F. Jarrell. Measurements of the emission lines of the mercury isotope 198 to an accuracy of eight figures were reported by William F. Meggers and Karl G. Kessler of the National Bureau of Standards.

At the dinner, Professor Shankland of the Case Institute of Technology extolled A. A. Michelson's work.

The Adolph Lomb medal was awarded to Dr. H. Richard Blackwell, professor of psychology at the University of Michigan, for his research and administrative ability in the field of vision. Dr. Blackwell, who received his Bachelor's degree in philosophy and his doctorate in psychology, headed the NDRC Tiffany project for visibility studies during the last war.

Excursions were made to the Case Observatory and General Electric's Nela Park (the audience observed the illumination of a room by one candle in a pumpkin).

PENNSALT ELECTS VICE PRESIDENT ASSISTANT

Albert H. Clem has been appointed to the newly created position of Assistant to the Vice President in charge of Sales of the Pennsylvania Salt Manufacturing Company, according to an announcement by William P. Drake, Vice President. Mr. Clem was formerly Assistant Manager of Sales in the company's Special Chemicals Department. In his new position he will handle special assignments for the Vice President.

A graduate of Penn State, Mr. Clem joined Pennsalt in 1938 in the Research and Development Division. He later transferred to the Special Chemicals Department as sales service representative in the Detroit area and was subsequently produce supervisor of Pennsalt cleaners before becoming Assistant Manager of the department.

RECENT TRANSLATIONS OF RUSSIAN PAPERS OF INTEREST TO THE GLASS INDUSTRY

Abstracts of five papers which appeared in the Russian journal of the glass and ceramic industries.

HARDENING OF GLASS

G. M. Bartenev continued his investigation on the hardening of glass by quenching in air blast, see THE GLASS INDUSTRY, February 1950, p. 86. In *Steklo i Keramika* (Glass and Ceramics), March 1950, p. 7-12, he gave formulae for calculating the temperature T_c from which the glass should be quenched and the pressure p of the air blast required to obtain the predetermined degree of hardening Δ.

If glass sheets are quenched from different temperatures, it is found that the degree of hardening achieved increases with this temperature up to the point T_c and remains independent of temperature if this is above T_c. In other words T_c is the lowest temperature at which the maximum degree of hardening can be attained.

The pressure p of air blast required to obtain a wanted degree of hardening depends on the size and arrangement of the nozzles from which the air issues and on the distance between the nozzles and the glass sheet which is being cooled. Bartenev's calculations are made for nozzles 0.5 cm. in diameter distributed in a chequer pattern in mutual distance of 2.5 cm. The distance between nozzles and glass is assumed to be 5 cm.

The degree of hardening is expressed as the optical path difference per cm. of sheet thickness, i.e. N/cm. The calculation is carried out for $\Delta = 2.5$ N/cm. or $\Delta = 1.35 \times 10^{-4}$ (pure number).

For calculating T_c and p, first the expression

$$I = \frac{\Delta\ (I - \sigma)}{B\beta E\ (T_g - T_o)}$$

is found. In it Δ is 1.35×10^{-4}, σ is the Poisson ratio of the glass, B is its optical constant, β its coefficient of linear heat expansion, E its modulus of elasticity, T_g is the temperature below which the volume stresses remain frozen in the glass, and T_o is the temperature of the cooling air. For glass containing SiO_2 71.3, Al_2O_3 0.7, CaO 7.6, MgO 3.3, Na_2O 15.9, SO_3 0.7, and Fe_2O_3 0.1%, σ is 0.22, B is 2.42×10^{-7} cm²/kg., β is 86×10^{-7} degree^{-1}, E is 675000 kg./cm², and T_g was found to be 573°C. With $T_o = 20$°C, this gives $I = 0.136$ (dimensionless).

Bartenev publishes tables showing the connection between the number I and another number δ_1, which is the first root of the equation $\delta \tan \delta = ha$, h being the coefficient of heat transfer (in cm^{-1}) and a the half thickness of the glass plate to be hardened. From $I = 0.136$ and $\delta_1 = 0.867$, $ha = 1.02$ is obtained; as $a = 0.3$ cm., h proves to be 3.40 cm^{-1}. The surface coefficient of heat transfer is $\alpha = \lambda h$, λ being the heat conductivity of the glass; for the instance considered by Bartenev $\lambda = 2.1 \times 10^{-3}$ cal./cm. sec. degree centigrade. Hence, $\alpha = 7.15 \times 10^{-3}$ cal./cm² sec. degree for Bartenev's glass. The coefficient of heat transfer by radiation α_2 is $0.93\ C\ (T_g^2 - T_o^2)\ (T_g^2 + T_o^2)$; 0.93 is the emissivity (relative radiation efficiency) of the glass, C is the constant of the Stefan-Boltzmann law of radiation equal to 1.38×10^{-12} cal./cm² sec. degree, and T_g and T_o are expressed in Kelvin (absolute) degrees. This equation gives $\alpha_2 = 1.17 \times 10^{-3}$. The coefficient of heat transfer by convection α_1 is $\alpha - \alpha_2$. Hence $\alpha_1 = 5.98 \times 10^{-3}$ cal./cm² sec. degree for Bartenev's glass.

The value of α_1 is used to calculate the pressure p of the air blast required to achieve the hardening of 2.5 N/cm. Bartenev's experiments showed that, for cooling by normal (i.e. perpendicular) air blast, the Nusselt (Nu) and the Reynolds (Re) coefficients are related by the equation $Nu = 0.028\ Re^{0.9}$. "Nu" is $\alpha_1 L/\lambda_o$, L being the width of the glass sheet (L was 24 cm. in Bartenev's experiments) and λ_o the heat conductivity of air, and "Re" is vL/ν, v being the velocity of air at the sheet and ν the kinematic viscosity of air. The pressure p is $3.75\ \gamma\ v_o^2$, if p is measured in mm.Hg, γ is density of air (g./cm³) and v_o is the velocity of air when leaving the nozzles. The relation between v and v_o depends on the arrangement of the nozzles and their distance from the glass sheet. If the experimental data are used to find it, the equation

$$\log p = 2.22 \log \alpha_1 + 0.22 \log L + 6.28$$

results. For the above values of α_1 and L, $p = 35$ mm.Hg. For the temperature T_c, the equation

$$\log T_c = \log T_g + \log \frac{\delta_1\ (\delta_1 + \sin \delta_1 \cos \delta_1)}{2\ \sin^2 \delta_1} + 0.87 \frac{\delta_1^2}{\delta_2^2 - \delta_1^2}$$

is derived, in it, δ_2 is not explained in the original. For Bartenev's glass, T_c is calculated to be 665°C.

REDUCTION OF THE DEGREE OF HARDENING OF GLASS BY GRINDING

Grinding or polishing of hardened glass lowers its degree of hardening. This effect was studied both theoretically and experimentally by G. M. Bartenev, *Steklo i Keramika* (Glass and Ceramics) 1950, No. 4, p. 7-9.

The surface layers of a hardened glass sheet are compressed (they tend to expand the sheet). When a part of these layers is removed, there is less difference between the interior and external layers, and the birefringence is smaller. If the degree of hardening is Δ (dimensionless; Δ is path difference between the two beams per cm. of glass thickness), then at a first approximation,

$$\Delta = B \frac{\beta E\ (T_g - T_o)}{1 - \sigma} \cdot \frac{\delta_1^2}{6} \left(\frac{d}{d_o} \right)^2$$

B is optical constant (in cm²/kg.), E is modulus of elasticity (in kg./cm²), β is coefficient of linear thermal expansion, σ is Poisson's ratio, δ_1 is a function of the rate of cooling (see THE GLASS INDUSTRY, February 1950, p. 86), T_g is the temperature below which the stresses remain frozen in the glass, T_o is the temperature of air blast, and d and d_o are the thickness of the glass sheet after and before polishing, resp.

Fig. 1 shows the agreement between the theory and the

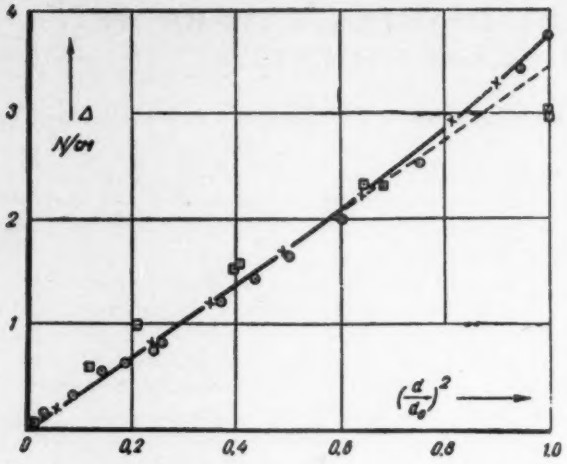


Fig. 1.

experiment. The degree of hardening Δ is plotted along the absicissa. The broken straight line represents the above equation, the continuous curve represents the unabridged equation, and experimental results are shown by crosses, circles, and rectangles. It is seen that the approximate equation above is sufficiently exact when the reduction of d by grinding is small.

If the above equation is sufficiently exact, the simple formula

$$\Delta = \Delta_0 \left(\frac{d}{d}\right)_0^2$$

can be used. In it Δ_0 is the degree of hardening before grinding. Hence, if Δ_0 is known, the hardening remaining after grinding to a definite d can readily be calculated. According to Bartenev, this simplified formula is successfully used in industry.

CORROSION OF REFRACTORIES IN THE FLAME ZONE OF GAS FURNACES

In Russia, sodium sulfate rather than sodium carbonate is used in glass batches. This causes corrosion of the roof and walls of the furnace above the level of the glass melt. A. I. Polinkovskaya, V. T. Savinov, and N. V. Solomin studied this corrosion and reported the results in *Steklo i Keramika* (Glass and Ceramics), April 1950, p. 16-20.

As salt vapors and dust in the atmosphere of the furnace are likely causes of corrosion, their chemical composition was determined first. Iron pipes, through which cold water flowed, were introduced into two furnaces between the first and the second and between the third and the fourth burners 8.5 cm. above the glass level, kept there for 21-25 hours at 1395-1445°C., withdrawn, and scraped off. The removed sediment, in one of the furnaces, had the following composition (expressed partly as salts):

Na_2SO_4	62-87%	SiO_2	3.1-7.2%
NaCl	2.5-13%	Al_2O_3	0.3-0.6%
NaF	2.4-2.7%	Fe_2O_3	0.4-1.8%
$CaSO_4$	1.9-6.8%	CaO	0.8%
$MgSO_4$	5.4%	MgO	1.1%

This composition should be compared with the compositions of the batch and the resulting glass. The batch (parts used to produce 100 parts of glass):

sand	70.12
sodium sulfate	26.75
soda	8.20
dolomite	15.45
calcite	2.88
anthracite	2.00
fluorspar	1.24
alumina	0.88
batch dust	0.70

The crude sodium sulfate used contained 3.5% sodium chloride. Thus, the batch contained 0.94 part NaCl for 100 parts of glass. It is seen that the concentration of NaCl in the sediment is much greater.

An analysis of the glass gave

SiO_2	71.72%
SO_3	0.25%
TiO_2	traces
Al_2O_3	1.24%
Fe_2O_3	0.20%
CaO	6.87%
MgO	3.43%
Na_2O	16.04%
F	not detd.
	99.75%

The amount of corrosive salts in the sediment is so great that the extent of corrosion observed in practice finds a ready explanation. The main component of the sediment is sodium sulfate, and observations showed that the corrosion of refractories above the glass level in the furnace paralleled that in liquid or dissolved sodium sulfate. In both instances, refractories on the alumina base (containing 89-90% Al_2O_3) were vastly superior to refractories on silica base (containing 96% SiO_2). Silica refractories, kept for 4 weeks near a burner in a glass furnace at about 1480°C., lost 54-91% of their original volume, while alumina (corundum) refractories lost less than 2% after a 6 weeks test.

THE RATE OF MELTING OF BRIQUETS

If the batch is introduced into a glass tank as briquets, what should be the size, shape, and other properties of these briquets? D. L. Gik and V. V. Pollyak discuss this problem in *Steklo i Keramika* (Glass and Ceramics) 1949, No. 10, p. 3-7.

Their experiments were carried out in a machine channel of a Fourcault furnace at 1125-1140°C. (2057-2084°F.). The air pressure in the chamber was positive to avoid cooling of the glass by intruding outside air. The briquets were placed either on the surface of the molten glass or on a refractory plate preheated to the temperature of the furnace and the time T was determined necessary for the complete melting of the briquet (i.e. for the disappearance of the "dark patch" marking the original position of the briquet as long as the temperature there is below the temperature of the surroundings). The composition of the briquet corresponded to a glass consisting of SiO_2 70.9, CaO 3.5, MgO 1.7, and Na_2O 23.9%. The binding material of the briquet was sodium silicate.

Table I shows that the variation of the specific gravity of the briquets between 1.72 and 2.02 had no effect on the time T.

TABLE I

SPECIFIC GRAVITY AND TIME OF MELTING

Briquet dimensions cm.	Mass g.	Sp. gravity	Active surface sq. cm./g.	Time T min.
9.9 x 6.9 x 3.3	387.5	1.72	0.43	27.5
10.1 x 7 x 2.85	387.5	1.93	0.44	27.5
9.8 x 7 x 3.5	390.0	1.80	0.44	27.0
10.5 x 7.2 x 2.55	390.0	2.02	0.43	27.0

Table II proves that introduction of 25% of glass powder (particle size about 0.2 cm.) did not affect the time of melting.

TABLE II

ADDITION OF GLASS POWDER AND TIME OF MELTING

Briquet dimensions cm.	Heating on	Composition batch	glass	Mass g.	Active surface sq. cm./g.	Time T min.
7 x 4.8 x 3.4	refractory	75	25	198	0.57	21
7 x 4.8 x 3.5	plate	100	0	198	0.58	21
10 x 7 x 3.45	glass	75	25	430	0.42	23
10.05 x 7.05 x 3.4	glass	100	0	430	0.42	23

Inclination of the briquet relative to the plane of the refractory plate on which it was placed also was irrelevant. Also a cylinder whose axis made an angle of 65° with its base had time T identical with the T of a right cylinder of identical dimensions.

On the contrary, the development of the surface of the briquet had a considerable effect on T. Thus, a hollow cylinder whose surface area was 0.85 cm²/g. showed a T of 4 sec./g. while a solid cylinder of equal mass (180 g.) whose surface area was 0.56 cm²/g. disappeared after 6.65 sec./g. The ratio of the T values was 1.66 while the ratio of the areas was 1.55. Such an approximate agreement between the two ratios was observed also when the surface of a prism was increased by very deep cuts. When the cuts were less deep, the ridges melted away first and the remaining smooth body behaved as the smooth standard briquet. In this instance the ratio of the T values was considerably less than the ratio of the original surface areas.

TABLE III

HEIGHT OF BRIQUETS AND TIME T

Mass g.	Height cm.	Surface area sq. cm./g.	Time T min.	Time T/Mass
150	2.0	0.69	22.0	0.147
300	4.0	0.49	28.5	0.095
442.5	5.9	0.44	33.0	0.075
600	7.9	0.41	37.5	0.0625
750	9.85	0.39	40.0	0.053

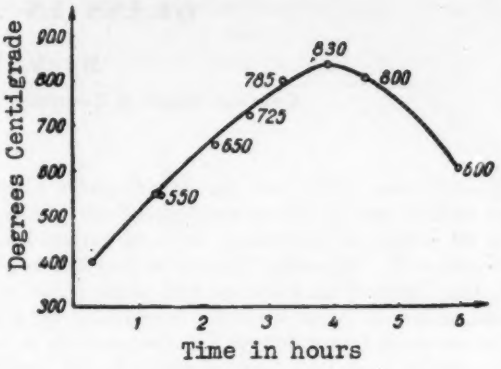


Fig. 1

Prismatic briquets, all having the base of 7 cm. x 6 cm. but different heights, were then compared. Table III lists the results. It is seen that the time required for complete melting of a unit mass of briquet decreases when bigger briquets are used. All these briquets were heated on a refractory plate.

Briquets placed on molten glass and, consequently, partly immersed in the melt, acquired the temperature of the glass more rapidly than briquets on a refractory plate, e.g., a briquet whose time T on the plate was 31 min. became invisible in molten glass after 23 min.

FOAM GLASS IN U.S.S.R.

A few data on the manufacture of foam glass in U.S.S.R. are disclosed by I. I. Kitaigorodskii in *Steklo i Keramika* (Glass and Ceramics) 1950, No. 4, p. 3-6.

Apparently, there is only one glass works ("Autosteklo") in Russia which produces foam glass. Finely ground glass (composition not given) is mixed with coke (amount not given). The particle size of either is not important. The mixture is placed in steel forms having the shape of truncated rectangular pyramids, the larger base being the open top, and the smaller base being the closed bottom of the form. The usual form is 45 x 35 x 12 cm. The amount placed in one form is 4 to 7.5 kg. according to the preferred specific gravity of the final product. This range of charges corresponds to the range 0.176-0.392 in specific gravity. The recommended amount is 5-6 kg. giving rise to foam glass of specific gravity 0.260.

The forms containing the batch are led into a tubular furnace through which exhaust gases are forced so that different sections of the furnace have different temperatures. The forms take hours to pass through the furnace, and the increase and decrease of their temperature is shown in Fig. 1 above. Heating causes gas liberation in the softened glass and an increase in volume such that the glass blocks now fill the forms.

Outside the furnace, the glass blocks are taken out, annealed in a tubular lehr, and cut to specifications with circular saws.

The bubbles in the finished product are about 0.5 cm. in diameter and are not connected with each other. The compression strength is 30 kg. weight/sq. cm. when the specific gravity is 0.25-0.30; it increases to 100 kg. wt./sq. cm. when specific gravity is 0.5, and reaches 1000 kg./sq. cm. when specific gravity is 0.7. At specific grav-

(*Continued on page* 660)

GLASS IN ANCIENT INDIA

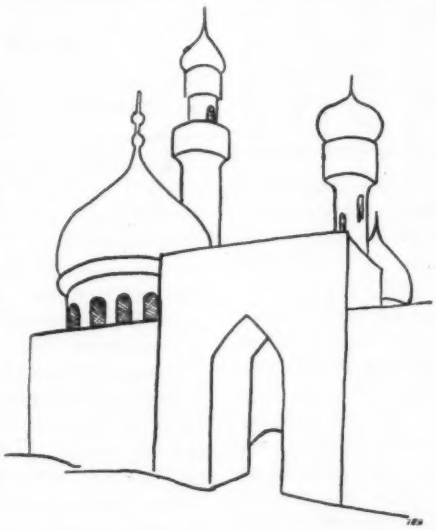
By Y. P. VARSHNEY

Central Glass & Ceramic Research Institute, Calcutta, India

Exactly when and where the first discovery of glass was made by man is still uncertain, but there is no doubt that the origins of glassmaking lie in the earliest history of civilization. Beginning from the earliest known glaze on stone beads of the Badarian age (about 12,000 B.C.) down to historic times when the invention of the blowpipe was made (about 300 B.C.), numerous finds of dateable ancient glass have been unearthed by the spade of the archeologist.

From these, the progress of glassmaking in ancient Egypt and the Middle East countries has been traced in fair detail. However, in literature relating to glass published abroad, very little is mentioned about China and nothing has been reported about any contemporary activity of that period in this direction in India. Civilization in both these countries is well known to be very ancient and in many developments they were ahead of their contemporaries in other parts of the world. In this article, therefore, an attempt has been made to gather in one place available authentic information concerning glassmaking in ancient India, and to see if it lends itself to any interpretation in the light of the development of glassmaking in the Middle East countries.

The Chinese, according to Salmony, made glass paste only in the Han period (about 200 B.C. to 221 A.D.) until glass blowing was done in the T'ang period (about 7th and 8th century A.D.). Literature of the Han period mentions glass as introduced from the West and until recently it was believed that the Chinese did not know glass working until the 5th century A.D. Certain finds, however, of Chinese buttons and fragments, and pendants in pre-historic tombs in Japan seem to contradict this supposition.



Regarding glassmaking in India, Pliny is cited in support of the statement that the ancient Indians knew glassmaking and how to color it by the addition of metallic salts and had acquired considerable skill in this work. However, this has been questioned by Kisa.

In ancient Sanskrit literature, there are many references to Kācha (glass) which show that glass was known in India in remote antiquity but nothing is given regarding the technique and skill of the Hindus in glassmaking. According to Maganlal Buch, the Arthasastra calls false gems "glass gems" and mentions the manufacture of glass, while K. P. Jayaswal writes that glass manufacture existed in India long before it became known to Ceylon about the 3rd Century B.C. Referring to the archeological discoveries made at Harappa and Mohenjo Daro, S. K. Das says that there is conclusive evidence of close contact between the civilization of northwest India and the Sumerian culture of Mesopotamia, both of which flourished about 5000 years ago. No glass object, however, which can with certainty be assigned to the Indo-Sumerian period has yet been found anywhere in India although ample evidence has been found testifying to the high technical skill of these people. Whether ancient India acquired the knowledge of glassmaking through such contacts with the Middle East countries or not still remains a moot question. Regarding the similarity of various finds (e.g., pottery) in Mesopotamia and Sind and Punjab, Majumdar writes—"But it is not easy to decide whether the migration started from the East or from the West. As regards the Indus people, those who inhabited Harappa and Mohenjo Daro, it cannot be said at once that they came from outside India although some of their objects certainly show points of technical resemblance with those of Persia, Mesopotamia, and Transcaspia of the Chalcolithic period. The household articles and arts and architecture of the Indus people show a distinct stamp of individuality which favors the conclusion that whatever be their ultimate origin, they must have settled in India for centuries and that it was here that their civilization reached its final stage of development."

Numerous fragments of glass objects of various kinds, bangles, beads, and imitation gems, dating from the 4th century B.C. downwards have been found at ancient sites in Upper India, and probably the biggest specimens of ancient Indian glass intact are those discovered by Marshall in excavations at Taxila, located near Sarai kala railway junction, 20 miles northwest of Rawalpindi. The origin of the earliest city of Taxila lay in the remote ages and it has been mentioned in the Mahābhārat. About the 5th century B.C. it was included in the Persian Empire. Taxila was a flourishing city when Alexander invaded India about 327 B.C. and its importance lay in its being on the trade routes between India, Central and Western Asia. The three main mounds at Taxila were Bhir, Sirkap and Sirsukh, of which the first represented the earliest city of Taxila and the third one the last. The city at Sirkap is believed to have been founded during the supremacy of the Indo-Greeks in the 2nd century B.C.

The specimens of such ancient glass reported to be in the Taxila museum include three complete conical flasks 5⅜" x 5⅜", 5½" x 2 5/16", and 6" x 2½" of sea green color and some tiles which average 10¼" square by 1⅛" thick and are of transparent glass of bright azure blue and a few other colors—black, white, and yellow. These tiles, in the course of the excavations, were

found laid in a somewhat careless manner on a bed of earth and it is believed that they formed the flooring of the procession path which ran over a raised terrace all round the Dharamarajika Stupa. The age of the Stupa is fixed by Marshall at about 1st century A.D. and that of the procession path about 3rd-5th century A.D. Describing the floor of the procession path Marshall writes:

"In the stratum immediately above this latter floor were found many pieces of glass tiles. Probably the whole of the procession path was at one time paved with these glass tiles, and later on when the pavement had fallen into disrepair, a number of the tiles were removed from here to the chamber F_1 where they were found, laid in a careless manner."

Mr. Sana Ullah, of the Archaeological Survey of India who initiated an investigation into the subject of glass in Ancient India, says that the flasks and the thin curved fragments indicate that these vessels had been formed by blowing. Besides, the very size of the tiles found at Taxila speaks much of the excellence of the technique that the Hindus must have acquired in order not only to mold such heavy articles, but also to anneal them satisfactorily. Even nowadays such heavy pieces of glass require much attention in annealing if they are to be free from undue internal strain which may otherwise cause them to fracture on cooling. Another interesting feature is the yellow color of some of the tiles. Any one familiar with present day glassmaking knows that it needs comparatively more care to get good shades of yellow in transparent glass than other colors. In all the specimens of ancient glasses analyzed and reported upon, notably the large number investigated by Neumann, the writer has not come across a single example of yellow color. Sana Ullah analyzed a number of ancient Indian glasses and his analyses are presented below but, as none of the yellow tiles has been reported upon, it cannot be said what coloring medium was used. However, from the analysis of a greenish blue tile it is clear that a fairly hard glass has been used and it must have needed a melting temperature which, even according to present day practice, must be considered fairly good.

Among the above samples, I and III are striking in certain respects. Sample I, described as thin drawn out strips of haematinum, contains PbO of an unusually high percentage not so far reported in any analyses of ancient glasses of earlier or contemporary periods which have come to the writer's notice, excepting in some blue Chinese beads of the Han period (about 2nd century, B.C.). Beck and Seligman found the chemical analysis of these beads to be—

SiO_2	41.9%
PbO	24.5%
BaO	19.2%
CaO	4.5%
Al_2O_3 & Fe_2O_3	4.4%
Alkalies	4.5%
CuO	trace

Among ancient glasses, this is also the first instance of a barium glass. In modern times barium glass was first made by Schott and his co-workers at Jena about 1884. Further, the use of lead oxide in glass in such large amounts almost anticipates the usage introduced about the 17th century A.D. when English crystal glass was made. Similarly, over two per cent antimony oxide in Glass III appears to be a notable departure from glassmaking practice in other ancient countries. In fact, introduction of antimony in appreciable amounts in special glasses is also a recent innovation. However, since the analysis reported is of a decomposed glass powder, it is perhaps uncertain whether the antimony oxide in the powder came from the glass or was an extraneous addition because no mention has been made of any microscopic examination or other test to determine this feature. The use of antimony oxide as a cosmetic is very ancient and the Indians of that age were fully conversant with the metallurgy of antimony and tin. Thus, the antimony oxide in the sample may well have come from the contents of the glass container which decomposed to form the powder analyzed by Sana Ullah.

TABLE I

SANA ULLAH'S ANALYSES OF TAXILA GLASSES

	I	II	III	IV	V	VI	VII	VIII	IX
OXIDE	Thin drawn out strips of Haematinum	Greenish blue glass	Turquoise blue powder of decomposed glass object	Fragments of light green glass	Greenish blue glass tile	Amethyst glass fragments	Brown glass fragments	Thin curved fragments of light blue color	Blue bangle
SiO_2	39.79	70.57	67.48	68.34	71.01	58.12	53.81	70.69	68.11
Al_2O_3	2.45	2.46	3.64	1.67	3.74	5.74	1.51	2.88	2.22
Fe_2O_3	—	1.60	—	1.20	1.84	1.74	8.47	0.81	2.27
Sb_2O_3	—	—	2.42	—	—	—	—	—	—
CaO	2.81	4.60	4.92	8.44	3.73	8.85	6.27	7.05	4.91
MgO	?	2.68	1.80	1.44	2.32	4.01	4.50	0.50	3.74
PbO	38.93	—	—	—	—	—	—	—	—
MnO	?	0.05	—	0.34	0.05	0.17	0.08	0.01	—
SnO_2	0.22	—	—	—	—	—	—	—	—
CuO	—	0.55	3.63	—	0.24	—	—	—	0.44
Cu	5.31	—	—	—	—	—	—	—	—
Na_2O	10.02	14.99	2.48	17.76	14.99	16.74	23.52	12.86	19.10
K_2O	0.57	2.65	0.55	0.94	2.65	4.83	2.35	4.85	—
H_2O	—	—	14.15	0.43	—	—	—	—	—
TOTAL	100.10	100.15	101.07	100.56	100.57	100.20	100.51	99.65	100.79

A reference has already been made to the composition of Glass V. However, it is not the only one with a high silica content of 71.01%, which is rather unusual for glasses of that period. Glasses II and VIII, too, have silica percentages of 70.57 and 70.69, respectively. In fact, if the R_2O_3 oxides are taken with silica, the acidic oxides in these glasses, viz., II, V, and VIII, are 74.63, 76.59, and 74.38, respectively. In the numerous antique glasses of various periods, Egyptian, Mesopotamian, Babylonian-Assyrian, Roman, etc., which Neumann has reported upon, the writer has not come across any but just one isolated instance of a Babylonian glass from Nippur, dating to about 250 B.C., in which silica is 71.14% and the total acidic oxides is above 74%. Even this Nippur glass differs from the Taxila samples mentioned above inasmuch as it has a total alkali content of about 12% only and CaO plus MgO content of over 10%. On the other hand, Taxila Glasses II, V, and VIII have alkalies, 17.64, 17.64, and 17.71%, respectively, while their CaO plus MgO contents are 7.28, 6.05, and 7.55%. It will thus be seen that these three glasses appear to stand out in a distinct class by themselves.

By comparing his own analyses of Indian glasses with

those of two glasses discovered by Lt. Col. Lane at Samarra, which he analyzed, Sana Ullah concluded that the recipes for glassmaking employed in Assyria were identical with those known in India in ancient times. Contrary to this conclusion, however, while the analyses of the Samarra glasses given by him are similar to analyses of other Samarra glasses reported by Neumann, they do not show the distinctive features pointed out above in the Taxila glasses. In fact, all these on the other hand point to a contrary conclusion, viz. that the origin of the Taxila glasses was probably quite distinct from that of other antique glasses. It is most difficult to resist the inference that glass manufacture was not only well practiced in ancient India, but that it had developed independently in this country, or even if the knowledge was originally acquired by the Indians from Middle East sources, by the time of Taxila it had existed long enough in this country for considerable progress along distinctive lines to have been made.

The analyses of other ancient Indian glasses reported by Sana Ullah are given in Table II.

TABLE II

	I	II	III	IV	V	VI	VII
OXIDE	Light blue glass fragment, Nalanda	Sky blue glass fragment, Nalanda	Green glass, rectangular object, Nalanda	Beads of opaque red materials, Nalanda	Black cylindrical weight 1" x ⅝" Udaygiri, C.I.	Bluish green bangle porous and partly decomposed, Kurkshetra	Small flat coral red beads, Assam
SiO_2	62.61	61.21	70.74	61.50	59.62	85.34	53.25
Al_2O_3	2.05	1.81	6.13	9.82	3.42	3.88	6.12
Fe_2O_3	1.61	1.60	1.54	FeO 7.01	3.21	1.72	9.16
MnO	0.06	—	trace	—	—	—	—
CaO	6.95	8.15	2.11	5.20	7.55	2.74	9.18
MgO	4.17	3.83	0.26	0.06	2.03	2.59	1.47
Cu	—	—	—	—	—	—	9.13
CuO	0.57	0.75	—	Cu_2O 0.49	—	2.53	—
Na_2O	17.85	18.25	15.80	15.92	4.10		11.69
K_2O	5.04	4.98	4.98		19.00	1.20 by difference	—
TOTAL	100.91	100.58	99.52	100.00	98.93	100.00	100.00

The first four glasses in the above table are from Nālanda, which was, to use Broadley's words, "the most magnificent and most celebrated seat of Buddhist learning in the world". It is believed to have come into existence sometime in the period intervening between the visit of the Chinese pilgrim Fa Hian (405 to 411 A.D.) and Yuan Chwang, who followed him in 630 to 645 A.D. This important center of Buddhist culture flourished for over 700 years. The fifth glass, however, is from a locality which is much more ancient. Udaygiri (Gwalior) dates approximately to the same period as Rajgiri and contains some of the oldest structures in India. Rajgiri in Bihar was originally the capital of Jarasindha, a prehistoric king of Magadh mentioned in the Mahābhārat. Coming to historic times, it was the capital of Bimbisara from 519 to 491 B.C., and it was a flourishing city till 231 B.C., at the death of Asoka. Thereafter it fell into decay and its locality was more or less desolate and in ruins when Fa Hian visited India early in the fifth century A.D. Similarly, Kurkshetra has an ancient past running back to the age of Mahābhārat.

Very recently, M. M. Nagar, Curator of the Provincial Museum at Lucknow, has reported in the press the discovery of what is believed by him to be the site of an ancient glass factory near Kopia, a place about 31 miles from Basti in U.P. The finds from this site are reported to include parts of clay crucibles (with glass sticking to them) in which the glass was presumably melted, large lumps of glass and tiny beads with very fine threading holes which are of a distinctive character. From the similarity of these glass beads with those found by Peppe in the remains of a Buddhist Stupa near the village of Piprahwa in the same district but about 35 miles away from the site of Kopia, Nagar concludes that the age of this glass factory may be placed about the 5th century B.C. Some of the specimens of glass found at the above site are under investigation in the laboratories of the Central Glass & Ceramic Research Institute, while Nagar has also suggested that a more thorough excavation by the Archaeoolgical Survey may yield further information on this subject.

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PPG THIRD QUARTER HIGHEST IN ITS HISTORY

Pittsburgh Plate Glass Company's sales of $93,493,210 for the third quarter of 1950 were the highest in the company's history, according to Harry B. Higgins, President. Sales were 28% above the $72,762,087 reported for the comparable quarter of 1949 and 14% above the previous high of $82,170,767 established in the second quarter of this year.

For the first nine months of 1950, sales totalled $245,449,903, a 15% increase above the $213,114,583 reported for the comparable period of the preceding year.

Reported net income for the third quarter of 1950, after all charges for federal, state, and local taxes, amounted to $12,929,477, equivalent to $1.44 per share of outstanding stock, as compared with $10,281,403, or $1.14 per share, for the third quarter of 1949.

SAFETY PROGRAM FOR TANK REPAIR

By EARL F. SCHAEFFER

General Engineering Dept., Owens-Illinois Glass Co., Toledo, Ohio

We, of Owens-Illinois Glass Company, are quite proud of our safety record—a frequency of 1.6 in our Glass Container Division as compared to a glass industry frequency of 7.98, and an all industry average of 10.14 for the year 1949—and feel that this safety record did not just happen, but was, and is, the result of a very definite safety program covering all phases of our operation, including glass tank repairs. Because of this company-wide, overall safety program, the establishment of an individual program covering one phase of the operation, such as tank repair, becomes much easier; in fact, it becomes just a specific part of the overall program.

Since this overall safety program ties in so closely with the specific ones, let us discuss it briefly and see what goes into making it tick.

First of all, there is what I like to call the "Common Sense Approach". This simply means applying good horse sense to teaching, preaching, and applying safety. Here is an illustration: A good many years ago, one of our safety directors, realizing that too many accidents were occurring in the operation of quarrying out glass when a furnace was shut down, decided to do something about it, if possible. How did he go about it? Well, the next furnace that was quarried out found this fellow in working clothes in there quarrying out glass. He got on the business end of a jack hammer and found out first hand what it was like to quarry glass out of a furnace. He found out for himself that most of the protective devices were too heavy, too hot, too uncomfortable, and he also found out that people were working too close together. As a result, he found lighter, more comfortable protective clothing and, by spreading out the people, succeeded in reducing accidents in this operation to practically zero. A simple, but horse sense approach.

There are numerous other illustrations, but they would be superfluous. Just remember to use a common sense approach to safety.

Another big factor in any safety program is *promotion*. There have been millions of lines of copy and about an equal number of pictures telling about safety promotion. I dare say we at Owens-Illinois have tried almost every scheme written about, and a lot that haven't been, and will continue to try new ideas and variations of old ideas in order to keep an active safety promotion program going. Where do you get ideas for promotion? Here's what happened at one of our plants that will show how things sometimes fall in your lap in the way of promotion.

Chris Bovchoupitopolis was typical of the stone cutters and brick masons making up the hot repair gang and, like practically all of them, had coal-black hair and a mustache which was a thing of beauty.

Catastrophe struck one day when old Chris, forgetting the foreman's injunction, got too close to an opening in the furnace wall just as the furnace man reversed the fire, and the stingout caught him full in the face. Safety goggles saved his eyes. The burns on his face were painful but, fortunately, not too serious. However, the fine flowing mustache was now just a stubble, a travesty on mustaches, and old Chris, looking in the mirror at the first aid station, broke down and cried like a baby. All of a sudden, however, he seemed to brighten up a little, and turning to his foreman who had helped bring him to first aid, asked if they could take a picture of his mustache. He then explained that he wanted to give each of the other members of the gang one of these pictures, with this written across the bottom, "If you don't want to look like this, be careful."

Does this promotion pay off? Well, as Will Rogers used to say, "All I know is what I read in the papers"—frequency 1.6 against an industry average of 7.98.

If it doesn't pay off, how then can you account for the fact that, in our largest plant, over 40 per cent of all suggestions turned in are safety suggestions? Promotion has made the people safety-conscious.

The other point, in connection with the overall safety program, I would like to make is the part supervision plays in a safety program. Unless supervision is 100 per cent sold on safety, and exhibits a sincere interest in doing everything in its power to support a safety program, all is lost.

There are a number of other points that could be brought out in connection with the overall program, but let us get on to the specific subjects, and some of these will be covered under those topics.

Emergency Repair

About 70 per cent of repairs normally coming under this category are unnecessary. Emergencies often come up because of a lack of proper inspection and preventive maintenance. In most instances, a well-planned inspection schedule allows taking care of repairs before the wall falls in, the tank drains itself in the basement, the checkers fall in, or any one of the many things that can happen suddenly to a glass tank. Just as a small amount of water will put out the biggest fire if it is used when the fire starts, so can a little wind on a hot spot, when it first shows up, stop what, if left alone, may shut down a tank or cause extensive emergency repairs.

In this connection, safety planning can go all the way back to the drafting board. Furnaces can be designed with regenerators so close that it would take a trained eel to squeeze through to make a sidewall inspection for hot spots, or even to move a wind pipe if a hot spot were found. I have seen tanks with buckstay so placed that it was impossible to get to the sidewall except by means of a ladder from underneath. Windpipes were placed when the tank started, and that's where they stayed—that is, until a block burned through and 12 inches of glass was lost which, in coming out, took windpipes and everything else in its way with it.

Proper design, plenty of room, properly placed catwalks, and sufficient light (where necessary) to make frequent and regular inspections is the first step in a safety program to *prevent* emergency repairs. Obviously, the

An address given before the Glass Division of the National Safety Congress.

second step is to make the frequent inspections, and the third step is to make hot repairs to prevent these repairs from becoming emergency repairs.

If emergency repairs become necessary, then the use of experienced, trained men, under good supervision, is the best way of assuring no accidents. Team work here is important, and good, cool-headed supervision is an absolute must.

For stopping furnace leaks, readily available water lances of proper length, fire hose and water connections conveniently located and in operating condition allow quick action and avert many dangerous situations. Occasional drills for the operating furnace personnel is advisable, as it serves the double purpose of training them and checking on equipment being in place and in operating condition at all times. These drills also enable you to see the fellows who are cool and collected, and those who get unduly excited and tend to blow up or go to pieces when hurrying or excited, and this is important, as you can then plan to use them in such a manner as not to be in the way or cause confusion when an emergency arises.

Hot Repair

Here again, furnace layout and provision for getting around the tank can be of great assistance in preventing accidents. In most instances, temporary platforms, runways, etc., can be built for the specific hot repair job, and this should be done wherever possible. Handrails around platforms may seem to be unnecessary, but many a nasty fall has been prevented by having them. Have you ever worked up on top of a port, trying to replace an invert arch that has fallen in? When you have dark goggles on, sweat in your eyes, your heart pounding like a bass drum from the heat, and flame belching its fiery breath up at you, you'll realize that a little thing like a handrail is a mighty big thing in the way of a safety measure.

In supervising men on hot repair work, there is one infallible rule to remember regarding working conditions: *Never send a man where you yourself would not go.* In fact, it sure helps morale if you do go in first. It may take just a little more time to set a fan to blow cool air into some hot hole where a repair is to be made, but the whole job will be done quicker and your men will be a lot happier and a lot less prone to have an accident if you take this little extra time.

There are times, however, on hot repair jobs, where it is impossible to make working conditions more than just endurable, and it is under these conditions that accidents occur easily. I have found that the best way of accomplishing something on this kind of job is to decide exactly what you want to do before getting in the heat, go in and do it, and get out as quickly as possible.

When a fellow is hot, sweaty, and tired, his temper is apt to be short and careful supervision is necessary. It is generally true that a pat on the back, while only a few vertebrae removed from a kick in the pants, gets much better results, and this is especially true when working conditions are not the best and a fellow is all tuckered out from the heat.

It goes without saying that every bit of protection possible, such as safety shoes, protective clothing, asbestos gloves, helmets, sweat pad, goggles, etc., should be used in hot repair work but, even here, common sense must be applied, as ability to move easily is sometimes more necessary from the safety standpoint than complete protection with heavy encumbrances. A suit of armor offers good protection to its wearer in case someone gets mad at him, but the ability to run might stand him in better stead.

Cold Repair

In making cold repairs to a glass tank, we usually think of a repair or a rebuild which involves a great amount of material handling and all its attendant hazards. A safety program for this phase involves the same considerations as the day-to-day safety program for steel workers, stone masons, brick layers, carpenters, welders, and laborers. The only other thing in addition is consideration of the fact that they are all working together in a relatively small area, and definite planning must be made to prevent over-congestion and to eliminate people working over other people where things may be dropped, causing injuries to those below.

This may be done by setting up a repair schedule which eliminates overcrowding and allows various parts to be worked on simultaneously without interference. For example: Dismantling of the melter, right and left checkers, revolving pots or forehearths, can all be done simultaneously without danger of material being dropped on anyone below and without being in each other's way. However, ports cannot safely be worked on while checkers are being removed or reset, for obvious reasons. The use of a schedule or rebuilding program plan thus allows the setting up of the safest way as well as the most efficient way to rebuild the tank.

Since safe handling of large quantities of materials, materials often very heavy and awkward to handle, is one of the prime considerations in the cold repair of glass tanks, it is readily seen that every mechanical aid for transporting and handling this material should be used to prevent strains and other injuries caused by lifting, pulling, shoving, and the like. Self-propelled, hand-guided, platform trucks are useful and save much manual labor.

Palletizing of bricks, refractory shapes, checker spools, and the like at the time of receipt make possible hauling of these materials to the job without further handling, saving many possibilities of injury.

In any operation of the magnitude of a cold repair, the simple matter of good housekeeping is important in prevention of accidents. A clean working area with a minimum of things laying around is necessary and supervision is necessary also to see that good housekeeping is maintained at all times. Just keeping everything in its place goes a long way toward preventing falls and the like, and a clean place to work is always conducive to lowering the accident rate.

In conclusion, I would like to summarize a few of the points covered to refresh our memories a bit.

1. For a strong overall safety program, use a common sense approach, never let up on promotion, and insist on sincere safety-conscious supervision.

2. Emergency repair program: emphasize preventative maintenance, proper design for easy accessibility, use

(*Continued on page* 660)

PRECISION THERMOSTAT FOR HIGH TEMPERATURES

The development of an improved precision thermostat by Dr. Wm. R. Eubank at the National Bureau of Standards is one that provides smooth, continuous control of an electric furnace within a very small range at temperatures between 1000° and 1550°C. According to the Bureau's report, the device is of the type in which the furnace winding itself serves as the sensitive element, forming part of a bridge circuit for control of a thyratron tube. The thyratron circuit then acts as a continuously variable valve, allowing just enough current to reach the furnace to compensate for a given temperature fluctuation. The new thermostat is highly sensitive and independent of normal fluctuations in line voltage. As it is convenient to operate, easily adjusted for any temperature, and reliable for periods of continuous operation from a few minutes to several days, it should provide a useful research tool in such fields as glass technology, metallurgy, ceramics, and cement chemistry, where automatic control of furnace temperatures has long been a problem.

In exploring new compositions of glass, refractories, portland cement, and other industrial products at the National Bureau of Standards, systematic phase-equilibrium studies have been of great value. However, one important difficulty in this work has been the necessity of maintaining the specimen under study at a constant high temperature until a state of equilibrium is reached. Even small fluctuations in temperature may result in erroneous data, especially in multicomponent systems. In an effort to obtain better temperature regulation than was possible with regulators currently in use, the Bureau therefore undertook the development of an improved thyratron regulator for temperatures above 1000°C. The resulting circuit maintains furnace temperatures constant within ± 0.1 degree C for several hours, and within ± 1.0 degree C for several days.

In the Bureau's thermostat, the output of an a-c bridge, one arm of which serves both as a resistance thermometer and as a heater element for the furnace, is amplified and applied to the control grid of a thyratron. When the resistance of the furnace winding changes slightly with temperature, the resulting unbalance of the bridge produces a difference in phase between the control voltage and the anode voltage of the thyratron. This phase difference determines the firing period of the thyratron, and the thyratron action is reflected to the bridge circuit through a transformer, thus controlling the amount of energy supplied to the furnace.[1]

Power is supplied to the bridge circuit by a constant voltage transformer. A variable autotransformer then reduces the voltage output of the voltage regulator to the value needed for a particular operating range. In series with the autotransformer primary is a variable resistance. This resistance is also connected in parallel with the 25-volt primary of a 250-volt-ampere transformer whose 1000-volt secondary is in the plate circuit of the thyratron.

The thyratron controls the furnace current by changing the impedance of the primary winding of the transformer. If the phase of the control voltage is such that no plate current flows in the thyratron, the transformer

[1]This type of circuit was first described by H. S. Roberts in *Temperature: its measurement and control in science and industry* (Am. Inst. Phys.), pp. 604-610, Reinhold Publishing Corp., New York (1941).

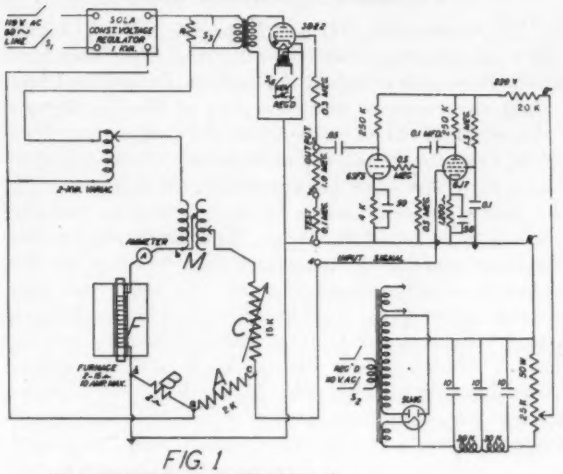


FIG. 1
THYRATRON QUENCHING
FURNACE THERMOSTAT

Figure 1. Circuit diagram of the precision thyratron thermostat developed at the Bureau for control of furnace temperatures between 1000° and 1550°C. The furnace winding *F* constitutes one arm of the a-c bridge, which through the amplifier controls the firing period of the 3D22 thyratron tube. The thyratron action is reflected to the bridge circuit by the adjacent transformer. If no plate current flows in the thyratron, the transformer is unloaded and impedance is high. Under these circumstances, a negligibly small current flows in the primary. But when the thyratron fires, the impedance of the primary coil becomes low relative to that of the parallel resistance *R*. The bridge current and thus the current through the furnace, is then increased, nearly the whole of it passing through the primary of the transformer. The reactance of the furnace winding in the ac-bridge is balanced out by adjusting the variable secondary of the mutual inductance *M*.

is unloaded and its impedance is high. Under these conditions, a negligibly small magnetizing current flows in the primary. When the thyratron fires, however, the impedance of the primary becomes low relative to the variable resistance. The bridge current, and thus the current through the furnace, is thereby increased, nearly all of it passing through the primary of the transformer. Thus the transformer reflects the high-voltage, low current characteristics of the thyratron switch into the power circuit as a low-voltage, heavy-current control.

The four arms of the a-c bridge consist of the furnace winding (about 2 to 15 ohms), a 2-ohm resistor, a 2000-ohm resistor, and a variable resistance consisting of a 5000-ohm coil and a 10,000-ohm decade box in series. The resistance of the furnace winding, which consists of about 100 g of 0.8-mm platinum—20%-rhodium wire, changes rapidly with temperature above 1000°C. and except for aging effects, maintains a definite relation to the temperature. The high ratio between the resistances on the two sides of the bridge is possible because the amplifier is voltage-operated.

Since alternating current is used, both the reactive and resistive components of the bridge must balance. For this reason, the resistance coils in the bridge, except those of the furnace, are noninductively wound. The reactance of the furnace is then balanced out by adjusting the variable

(*Continued on page* 658)

BOOK REVIEW

Physical Properties of Glass

By J. E. Stanworth. VII + 219 pages. Oxford University Press, London, 1950 (114 Fifth Ave., New York 11). $4.75. Reviewed by Robert F. Ferguson, Zanesville, Ohio.

Lest anyone throw away his copy of George Morey's "Properties of Glass" (Reinhold Publishing Co., New York, 1938) in the belief that Stanworth's book will give him a more up-to-date presentation of the same material, the author himself hastens to explain that he includes no data to be found in Morey. He could have said that the book contains no numerical data whatever on the properties of glass except those actually needed for purposes of illustration. A more descriptive title might have been "A Summary of Current Theories on the Constitution of Glass". Under the proposed title, the author would have done a tidy job. All of the recent work on the constitution of glass has been assembled from widely scattered literature, and the essential facts condensed and critically compared. Starting naturally enough with the ideas of Zachariasen and the brilliant confirmation of these ideas by B. E. Warren and his followers, the author continues with the pyramiding literature of the atomic spacing in various glass systems.

One sour note, however, sounds through this music of the spheres. After giving the reader the blessed assurance that each silicon is surrounded by four oxygens and that all is well with the silica tetrahedron, the author intrudes the possibility that these concepts could be merely averages and that the glass might be teeming with silicon atoms surrounded by more of fewer oxygens.

In compiling the literature on the constitution of glass, Stanworth has done a good job considering the material. But so much of the modern publications on glass chemistry remind this reviewer of the old confidence game of the Forced Choice. In this game, you remember, the victim is asked to choose some cards, but the dealer fails to announce beforehand whether the chosen cards will be picked up or left down. A crystal changes from blue to red indicating that the ion in question is in the network, or again, another substance will change from blue to red indicating that the ion is not in the network. Confirmation is offered by four other ions that fit beautifully into the theory—well, not too beautifully because one is out of line but in the right direction. Parenthetically, two ions do not fit into the theory at all, but these are exceptions. Unfortunately, the two ions that are exceptions to the first theory are not the same that are exceptions to the next theory.

Part I is frankly labelled as dealing with the structure of glass and occupies one-third of the text. Two other parts are included, one about the glass when it is definitely a solid and one about glass in the liquid state and in the transformation range. Although the titles of Parts II and III include the word "Properties", the author is obviously interested in these properties only insofar as they can throw more light on the structure. For example, a great deal can be learned about the texture of a material by seeing what will go through it and how. Consequently, Stanworth devotes a chapter to the diffusion of metal ions and gasses through glass, a subject which is not mentioned by Morey in a book three times as long.

The chapter on electrical properties concedes that the behavior of glass towards alternating currents is of great technical interest, but since these properties do not contribute to an understanding of glass structure, AC is largely ignored for the more interesting behavior under DC potential. In the same way, the surface of solid glass is examined, not from the viewpoint of the durability of commercial products, but in the hope of learning what molecular differences may exist between the surface and the parent body.

Fracture and mechanical strength are given the fullest treatment of all, and together these topics take up a fourth of the book. Again, the author is not concerned with test results, but rather with the theory of the strength of glass. The influence of external conditions and specimen size are considered insofar as these factors might be useful in a comprehensive theory.

By this time the reader should know what to look for in other chapters. Transformation range, viscosity, annealing, and devitrification are covered fully but only in a theoretical manner. The book is the sixth volume of a series entitled Monographs on the Physics and Chemistry of Materials issued under an impressive board of editors. This volume obviously has been heavily influenced by the editorial necessity of the series, which is addressed to physicists in research laboratories. A well-educated physicist with broad interests would find in the book a summary of the physical properties of glass carefully compiled, conveniently arranged, and critically annotated, but "physical properties" would still carry a physicists definition.

Your untutored reviewer would be the last to insist that the art of experimentation is a nobler pastime than the sciences of chemistry and physics as now practiced. The inner workings and life habits of the atom deserve the attention of our best minds. To others, however, a chemical or physical property will continue for some time to mean something that can be measured, and something that can be defined by describing the method by which the measuring is done.

SEABOARD GLASS CORPORATION PURCHASES GLASS INVENTORY

The Seaboard Glass Corporation has purchased the entire inventory of Vita glass from the Vitaglass Corporation, manufacturer of ultraviolet transmitting window, Cathedral, and wire glass.

This transaction included all of the Vita glass on hand at the Mississippi Glass Company's Washington, Pa., factory and on hand at other locations. Full information regarding Vita glass and Vita glass sales will now be handled by Seaboard Glass Corporation at their Brooklyn, N. Y. offices and warehouse.

GLASS FIBERS SALES SHOW SHARP INCREASE OVER 1949

Glass Fibers, Inc., had sales of approximately $2,236,000 in the first nine months of 1950, compared with $717,000 in the corresponding period of 1949, the company's third quarter statement to the Securities & Exchange Commission shows.

Sales of $815,000 in the September quarter this year compared with $931,000 in the preceding three months and $295,000 in the September quarter a year ago, the statement showed.

INVENTIONS AND INVENTORS

A Summary of Recently Issued Patents of Interest to the Glass Industry

Feeding and Forming

Press Mold. Fig. 1. Patent No. 2,526,588. Filed March 22, 1946. Issued Oct. 17, 1950. One sheet of drawings. Assigned to Raytheon Manufacturing Company by Wallace H. Small. This mold is designed for making button-type glass seals for the lead-in wires of electron discharge tubes.

The apparatus comprises an upper mold 1 and a lower mold 2 with a press plunger 9 movable vertically in the upper mold. The lead-in wires 17 are inserted in a series of holes so that they project to the desired extent. The charge of molten glass is placed on the top of the lower mold and pressed into the shape shown which is said to have considerable advantage over the buttons formerly used.

The references cited by the Patent Office were 1,965,408, Eden et al, July 3, 1934; 2,324,385, Gustin et al, July 13, 1943; and 2,334,784, Miller, Nov. 23, 1943.

Furnaces

Electrode for Melting Glass. Patent No. 2,526,241. Filed May 12, 1948. Issued Oct. 17, 1950. One sheet of drawings, none reproduced. This is an invention by Pierre Henri La Burthe and Roger Emile Lambert, Paris, France, assignors to Societe Anonyme des Manufactures des Glaces et Produits Chimiques de Saint-Gobain, Chauny & Cirey, Paris, France.

An electrode of carbon or graphite projects through the tank wall into the molten glass. This electrode is surrounded by a bearing which is in turn surrounded by a cooling jacket. By pushing on the bearing, the electrode may be projected further into the glass.

The patent contains two claims and 27 references were cited by the Patent Office.

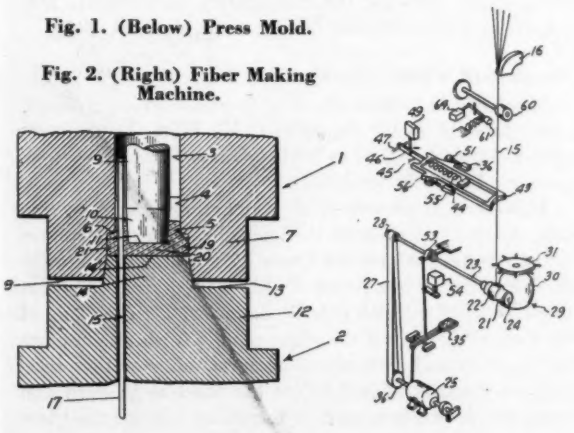
Smelter for Vitreous Frit. Patent No. 2,527,144. Filed Sept. 21, 1949. Issued Oct. 24, 1950. Two sheets of drawings, none reproduced. Assigned to Chicago Vitreous Enamel Product Co., by Floran L. Meacham and Joseph H. Greenberg.

The smelter comprises a screw feeder for delivering the raw material to an inclined floor where it is melted by heat under control of a damper. The melt then goes to the quenching medium. The particular feature of the invention as set forth in the single claim relates to the construction making the heating conditions better than usual.

The refereces cited by the Patent Office were 363,292, Howell, May 17, 1887; 576,734, Ludford et al., Feb. 9, 1897; and 839,220, Speer et al., Dec. 25, 1906.

Fig. 1. (Below) Press Mold.

Fig. 2. (Right) Fiber Making Machine.



Glass Compositions

Soft Glass. Patent No. 2,527,693. Filed Nov. 20, 1946. Issued Oct. 31, 1950. No drawings. Assigned to Corning Glass Works by William H. Armistead. This glass is adapted to be reshaped to make electric sign lights, cathode ray tubes, and the like.

The patent gives 10 examples of compositions coming under the claims, these compositions being given in per cent by weight as calculated from the batches on the oxide basis. The first six of these compositions is given below.

	1	2	3	4	5	6
SiO_2	71.7	71.7	69.7	68.5	70.1	66.5
Al_2O_3	8.4	8.4	10.4	8.4	8.4	7.5
K_2O	2.6	6.6	4.6	4.6	2.1	2.5
Na_2O	14	10	12	11.2	13.7	11.5
Li_2O	1.3	1.3	1.3	1.3	1.0	1
F	2	2	2	2	1.7	2
ZnO	...	...	...	4	...	...
BaO	...	...	...	...	3	9
CaO	...	...	...	...	...	...
B_2O_3	...	...	...	...	...	...
Softening Point, °C.	623	646	638	637	632	628
Strain Point, °C.	386	395	401	409	395	401
Soft.-Str	237	251	237	228	237	227
Exp.$\times 10^7$	92.8	91.0	91.6	90.2	91.1	91.3
Sp. Gr.	2.41	...	...	...	...	2.56
Ohm cm.$\times^{-5}$ @ 350°C	1.5	11	4	6	2	6.6
Stability	.07	...	...	...	...	.15
Batch Cost in cents per lb. of glass	1.7	...	...	...	...	2.0

The references cited were Dalton, No. 2,392,314, dated Jan. 8, 1946, and French Patent No. 870,982 of 1942.

Enamel. Patent No. 2,527,884. Filed Jan. 29, 1949. Issued Oct. 31, 1950. No drawings. Assigned to Cutler-Hammer, Inc., by Fred H. Kaufmann.

This patent discloses a composition to be used as a coating on metal and the method of preparing it. The patent contains six claims, the first of which is: A vitreous composition consisting of silica in amounts ranging from 15 to 30%, boric oxide in amounts ranging from 6 to 20%, barium oxide in amounts ranging from 15 to 40%, fluorspar in amounts ranging from 17 to 35%, zinc oxide in amounts ranging from 3 to 10%, alumina in amounts ranging from 1 to 8%, and cobalt oxide in amounts ranging from 0.5 to 3%, said percentages being by weight based on the total weight of said vitreous composition.

The references cited by the Patent Office were Migeot, No. 1,833,087 dated Nov. 24, 1931 and Hull et al. No. 2,272,747 dated Feb. 10, 1942.

Glass for Bifocal Lenses. Patent No. 2,528,634. Filed Sept. 16, 1949. Issued Nov. 7, 1950. No drawings. Assigned to Corning Glass Works by William H. Armistead.

This glass is particularly adapted for making the small inserts used in bifocal lenses, but of course it may have other uses. The patent gives 11 examples of compositions coming under the claims, the first six of which are given below. These examples do not include arsenic oxide which may be used as a fining agent and are given in per cent by weight as calculated from their batches on the oxide basis.

	1	2	3	4	5	6
SiO_2	45	34.4	36.2	38.5	35.6	36.5
K_2O	4.5	7.6	7.4	7.4	5.5	4
Na_2O	5.5	0.5	0.7	1.6	1.4	4
Li_2O	..	..	..	..	..	..
PbO	40	48.7	48.9	47.5	50.7	45
Al_2O_3	2	2	2	2	2	2
ZrO_2	3	3	3	3	1	5
TiO_2	..	3.8	1.8	..	3.8	2.5
Sb_2O_3	..	..	..	..	..	1
n_D	1.616	1.700	1.680	1.653	1.700	1.687
Expansion Coefficient $\times 10^7$...	89	88	89	90	89	88

No references were cited by the Patent Office.

Glass Wool and Fiber

Manufacture of Fibers. Patent No. 2,526,775. Filed Feb. 13, 1943. Issued Oct. 24, 1950. One sheet of drawings, none reproduced. Assigned to Owens-Corning Fiberglas Corporation by Games Slayter and Ed Fletcher.

According to the method and apparatus of this patent, the molten glass flows out through a number of small openings in about the usual manner. The fibers first go through an air blast from a cooling blower which may also control the rate of drawing the fiber. A lubricant is then applied to the fibers which pass through an opening in a blower discharging fluid pressure spirally around the fibers which twists the fibers into a strand ready to be wound on a spool. A modification of the apparatus is shown in the patent.

The patent contains six claims and the references cited by the Patent Office were: 2,067,251, Taylor, Jan. 12, 1937; 2,133,236, Slayter et al., Oct. 11, 1938; 2,206,058, Slayter et al., July 2, 1940; 2,209,850, Shand et al., July 2, 1940;2,212,448, Modigliani, Aug. 20, 1940; 2,216,759, Simison, Oct. 8, 1940; 2,272,588, Simison, Feb. 10, 1942; 2,300,736, Slayter et al., Nov. 3, 1942; 2,332,274, Slayter, Oct, 19, 1943; and 2,369,481, Modigliani, Feb. 13, 1945.

Insulating Blanket. Patent No. 2,526,870. Filed Nov. 24, 1947. Issued Oct. 24, 1950. One sheet of drawings, none reproduced. Assigned to North American Aviation, Inc., by Donald Jelinek and George C. Frey.

This patent does not relate to the manufacture of glass in any form but rather to the manufacture of an insulating blanket from glass fiber previously made.

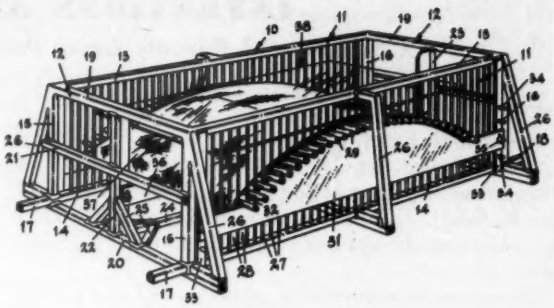


Fig. 3. Sheet Bending Machine.

Glass fibers are placed on a sheet of heavy paper which is then rolled upon itself and heated, which burns out the paper and smooths out the fibers. This reduces the thickness of the blanket while keeping its insulating value.

The patent contains 13 claims and the references cited by the Patent Office were: 2,016,401, Thomas, Oct. 8, 1935; 2,172,153, McClure, Sept. 5, 1939; 2,428,653, Collins, Oct. 7, 1947; 2,461,841, Nordberg, Feb. 15, 1949.

Fiber Making Machine. Fig. 2. Patent No. 2,527,502. Filed March 15, 1946. Issued Oct. 24, 1950. Three sheets of drawings. Assigned to Owens-Corning Fiberglas Corporation by Allen L. Simison and Ralph McK. Stream. A particular feature of this invention is a construction by which the drawing of the fiber is continued while a full spool is removed and an empty one substituted.

The figure is schematic showing the fibers as a strand 15 coming from the usual feeder and passing over a guide 16 and winding onto a power driven spool 21. A slide 43 is urged toward the strand by a spring, but it is held away from the strand by a latch which is released after a predetermined time by a timer mechanism.

When the operator depresses a pedal 35, the slide is retracted and the winding operation is started. After a time determined by the timer, the strand is engaged by rolls 60 and 61 which continue the drawing operation at a slower rate while a new pool is placed in position. The mechanism is electrically controlled so that very little work is required of the operator.

The patent contains 17 claims and the references cited were: 1,822,415, Niogret, Sept. 8, 1931; 1,898,206, Niogret, Feb. 21, 1933; 1,935,524, Schweiter, Nov. 14, 1933; 2,234,986, Slayter et al., Mar. 18, 1941; 2,302,715, Reynolds et al., Nov. 24, 1942; 2,305,085, Jacob et al., Dec. 15, 1942; and 2,398,808, Slayter et al., Apr. 23, 1946.

Sheet and Plate Glass

Sheet Bending Machine. Fig. 3. Patent No. 2,526,359. Filed July 28, 1947. Issued Oct. 17, 1950. Three sheets of drawings. Assigned to Libbey-Owens-Ford Glass Company by Joseph E. Jendrisak.

This device comprises a rectangular frame having sides made of a series of vertical tubular metal members 11. Extending across the frame and projecting through the members 11 is a series of thin walled pipes 29 about five-eighths of an inch outside diameter. On each side of the frame there is a template plate 31 which supports the pipes 29 and determines the curve made by the pipes. A glass cloth is placed below the sheet to be bent and when the device is placed in a heating furnace the glass

sheet drops to conform to the curvature determined by the templates 31.

The patent contains seven claims and the references cited by the Patent Office were: 833,436, Borland et al., Oct. 16, 1906; 991,025, Robier, May 2, 1911; and 2,223,-124, Owen, Nov. 26, 1940.

Device for Supporting Sheet Glass. Patent No. 2,526,-815. Application filed Oct. 6, 1947. Issued Oct. 24, 1950. One sheet of drawings, none reproduced. Assigned to Blue Ridge Glass Corporation by Theodore W. Glynn.

The single claim of the patent is as follows: In a device for supporting a glass sheet vertically during heating, the combination with knife edges below the bottom of the sheet, a vertical run of wire on each side of the sheet supporting the said knife edges, a weight pendent from said wires, pulleys over which the said runs of wire pass, a carrying bar and brackets movable on said bar and means for clamping the brackets to the bar.

The references cited by the Patent Office were Forbes No. 2,062,567, dated Dec. 1, 1936, and Great Britain, No. 525,948, dated Sept. 6, 1940.

Miscellaneous Processes

Sealing Fixture. Fig. 4. Patent No. 2,522,949. (One sheet of drawings.) Assigned to Western Electric Company, Inc., by Vincent G. Jarman of Belleville, N. J.

The parts to be sealed comprise a glass tube 10, a copper disc 11, and the parts 12, 14, and 15 which have been previously sealed together. The apparatus includes two main units 20 and 21 and associated parts by which the parts to be sealed are held in proper position. High resistance metal rings 34 and 42 are provided for heating the parts with the aid of a high frequency coil 52. After the parts have been heated, they are moved into contact as shown in the figure and seal is made.

The apparatus is adapted to be incorporated in a turret type machine and intermittently advanced to a series of working stations. The patent contains 5 claims and the references cited were 2,048,556, McArthur, July 21, 1936; 2,125,316, Ronci, Aug. 2, 1938; and 2,386,820, Spencer, Oct. 16, 1945.

Gauge for Screw Finishes. Fig. 5. Patent No. 2,525,-136. Filed Aug. 12, 1946. Issued Oct. 10, 1950. One sheet of drawings. Assigned to Hartford-Empire Company by Henry W. Ingle.

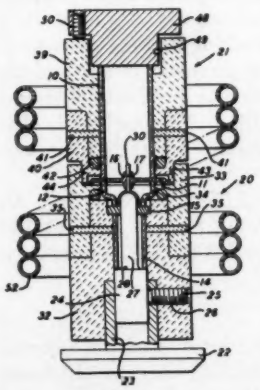


Fig. 4.

The drawing is practically self-explanatory. The jar 5 is positioned by three pins 16. A pivoted contact member 13, which bears against one or more threads of the finish, is engaged on the other side by the feeler of a dial gauge 20. When the jar is turned, the pointer of the dial will indicate if the finish is out of round. If it is too much out of round, it is discarded.

The patent contains three claims and the references

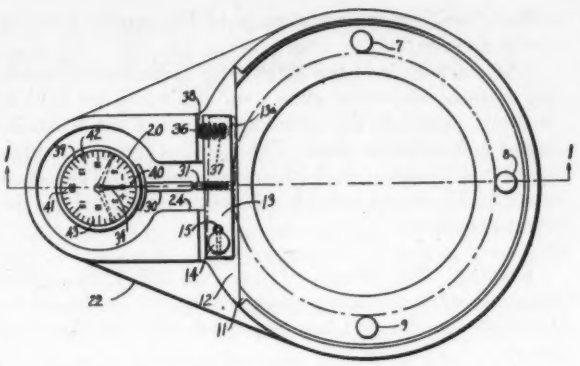


Fig. 5. Gauge for Screw Finishes.

cited were: 1,139,936, Warner, May 18, 1915; 1,446,149, Benoit, Feb. 20, 1923; 1,648,497, Moore, Nov. 8, 1927; 2,258,760, Hecker, Oct. 14, 1941; 2,413,841, Minuto, Jan. 7, 1947; and 2,415,693, Ingle, Feb. 11, 1947.

Glass Tube Bending Machine. Fig. 6. Patent No. 2,523,015. One sheet of drawings. Assigned to General Electric Company by Alfred Greiner of Cleveland Heights, Ohio. The invention provides a machine for coiling glass tubes which have been previously coated internally with fluorescent material; that is, for use in fluorescent lamps.

The tube 1 is supported on rollers 2 and it is advanced by feed rollers 3 and 3'. Suitable connections are provided for driving from a motor 8. The tube passes through an electric furnace 19 and then through an electric heating shoe 21 which supplies most heat to the upper side of the glass tube as this is the side that is stretched most in the bending operation. The tube then passes through power driven rollers 22 and 23 to a reshaping mold or die 24. Just before it reaches the reshaping mold, it is further heated by burners 32. The mold has a groove extending through 180° which shapes the advancing tube into a circle or a helix according to the shape of the groove. The circle can not extend through 360°. A helix can be wound onto a cylinder.

The references cited are: 603,175, Collins, Apr. 26, 1898; 1,874,012, Hotchner, Aug. 30, 1932; 2,006,389, Fuchs, July 2, 1935; 2,113,428, Hanna, Apr. 5, 1938; 2,208,958, Brown et al., July 23, 1940; 17,797, Great Britain, A. D. 1887; and 396,018, Great Britain, Oct. 19, 1931.

General Electric Company Stem Making Machine. Patent No. 2,518,924. (Four sheets of drawings not reproduced here.) This invention by Everett Niles, Willoughby, Ohio, relates particularly to the manufacture of incandescent lamps and similar devices having the so-

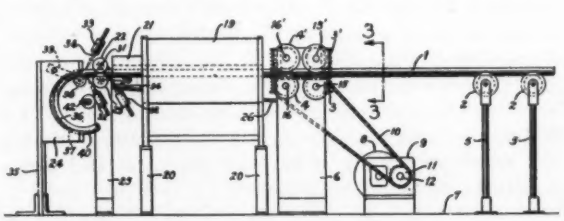


Fig. 6. Glass Tube Bending Machine.

called "ring" type arrangement of the lead-in wires in the glass stem.

The machine is of the turret type having twelve working stations where the glass stem and wires are held in position, heated to the softening point and the wires inserted and sealed in place. The machine operates at high speed and produces work of superior quality. The patent contains 11 claims and 16 references were cited by the Patent Office.

Bending Glass Sheets. Patent No. 2,518,951. (One sheet of drawings not reproduced here.) Assigned to Libbey-Owens-Ford Glass Company by William A. Smith.

The invention relates particularly to a hinge type mold which can be straightened out into a more or less flat position to receive a sheet of glass after which the mold is shaped to the desired curve to which the sheet of glass conforms under the influence of heat and gravity. Specifically, the invention provides a novel device for positioning the sheet on the mold by which the work may be performed more rapidly and with an improvement in quality.

No references were cited by the Patent Office.

Glass Seal. Patents No. 2,522,523 and 2,522,524. (The single sheets of drawings in each of these patents are identical and are not reproduced here.) The patents were assigned to Corning Glass Works by Robert V. Lukes. The first patent relates to the article and the second to the method of making it, the second having been divided from the first. The patents relate to forming seals between fused silica or high silica glasses and metals or between glasses having different thermal expansion coefficients.

The first patent gives full directions for making the article which is defined in Claim 1 as an article comprising at least two integral sections each formed of an individually distinct silicate glass, the glass of one of said sections having a lower weight percentage of silica than the other, said section having a lower concentration of canstituents other than silica in its outer portion than in its interior.

The references cited in this patent were 515, Heil, Feb. 20, 1894; 577,283, Caffall, Feb. 16, 1897; 1,014,757, Keyes et al., Jan. 16, 1912; 2,215,039, Hood et al., Sept. 17, 1940; 2,303,746, Nordberg et al., Dec. 1, 1942; 2,336,227, Dalton, Dec. 7, 1943; and 2,344,630, Mylchreest, Mar. 21, 1944, of which the patent to Dalton was the only one cited in the second patent.

The specification of the second patent on the method appears to be almost identical with that of the first patent. It contains 11 claims and Claim 1 is as follows: The method of treating an article composed of a glass containing at least 94% SiO_2 and having intercommunicating pores throughout its mass, which comprises impregnating at least a part of the article with a solution containing a compound of a glass-making oxide to substantially fill the pores therein, immersing the impregnated part in a solvent for the compound to remove part of the compound from the surface portion thereof, drying the article and firing it to close the pores and incorporate the oxide into the glass.

Electrically Conducting Coating on Glass. Patent No. 2,522,531. (One sheet of drawings not reproduced here.) Assigned to Corning Glass Works by John M. Mochel, this process is known as iridizing and it is used on the thin glass of the picture forming screen in an iconoscope tube. The same process can be used on mica.

This method comprises the steps floating a thin sheet of glass or mica on a molten bath containing tin at a temperature 600° and 700°C., and atomizing the floating sheet with a solution containing stannic chloride until an interference color beyond white of the first order appears.

The patent contains five claims and the references cited were 2,026,086, Farncomb, Dec. 31, 1935; 2,118,795, Littleton, May 24, 1938; and 2,165,773, Wheeler, July 11, 1939.

Glass-to-Metal Seal. Patent No. 2,522,990. (One sheet of drawings not reproduced here.) Assigned to General Electric Company by Paul O. Cartun, this patent is a division of the application resulting in Patent No. 2,427,711. It relates to the manufacture of electric lamps and similar things.

In brief, the invention consists of the method of sealing a glass tube to a metal cap in which the flare on the tube is larger than the cylindrical flanged end of the cap and then manipulating the parts while heated so as to increase the sealing area and otherwise improve the seal.

There are two claims in the patent and the only reference cited was British Patent No. 410,313 dated May 17, 1934.

Glass-to-Metal Seal. Patent No. 2,523,155. One sheet of drawings, none reproduced. William E. Shoupp assigned this invention to Westinghouse Electric Corporation.

The invention is defined in Claim 1 of the patent as the method of producing a vacuum-tight seal between a copper coated alloy member and a boro-silicate glass, the alloy being comprised of approximately 30% nickel, 18% cobalt and the remainder iron, which includes heating the copper coated member in a hydrogen atmosphere to a temperature at which the copper becomes substantially fluid, and thereafter fusing the glass to the copper coated member.

The patent contains 17 claims and 10 references were cited by the Patent Office.

Jig for Making Glass Sealed Switches. Patent No. 2,523,903. Three sheets of drawings, none reproduced. Assigned to Bell Telephone Laboratories, Inc. by Walter B. Elwood.

This device holds the glass tubing and the parts to be enclosed there by the help of magnetic means and the parts are vibrated so as to overcome any friction tending to hold them in improper position. The machine is electrically controlled and has means for regulating temperatures, air pressures, etc.

The references cited were: 2,353,783, Noel, July 18, 1944; 2,391,573, Herzog, Dec. 29, 1945; 2,406,008, Ellwood et al., Aug. 20, 1946; and 2,406,021, Little, Aug. 20, 1946.

• Laclede-Christy Company has announced the removal of its executive, fiscal, and operations offices to 310 South Michigan Avenue, Chicago 4, Illinois.

Research Digest

The Hardness of Glass

The resistance of glass to grinding and to indentation does not provide the same measure of hardness. In the April 1950 issue of the *Journal of the Society of Glass Technology*, W. H. Willott has attempted to measure the resistance to grinding in terms of the volume of glass per minute removed by grinding by a specific abrasive applied under a fixed pressure.

Examination of the results which the author obtained indicated that there was a definite relationship between this grinding or dynamic hardness number and the glass composition. From an analysis of the results, the following additive factors per 1 per cent of the constituent oxide were deducted.

Silica	+10.0
Boric Oxide	+ 6.1
Soda	— 3.7
Potash	—10.2
Lead Oxide	— 0.9
Lime	— 4.3
Zinc Oxide	— 0.6
Barium Oxide	— 0.7
Alumina	— 3.5
Antimony Oxide	— 0.7

The following table gives typical results illustrating the agreement between the experimental and calculated values.

	Experimental Hardness	*Calculated Hardness*
Silica	1000	1000
Sheet Glass	570	605
Hard Crown	453	453
Borosilicate Glass	515	515
Light Flint	426	442
Telescope Flint	563	563
Extra Dense Flint	294	285
Dense Flint	331	342
Double Extra Dense Flint	296	238
Dense Barium Crown	386	386

The following was used to illustrate the use of the quantity "grinding hardness" (G.H.). Since optical glass is usually roughly ground into plates, values were required for the comparative rates of grinding various glasses. Measurements were made in the factory on the usual grinding tables, the glass being held in contact with the table by a man of average build and strength. The volume of glass removed in each case was determined.

From the result for a borosilicate crown, comparable figures were calculated for the other glasses from their respective grinding hardness numbers. The table illustrates the agreement achieved.

Glass Type	*Hardness (G.H.)*	*Volume Removed c.c./min.* *Actual*	*Calculated*
BSC	515	21.5	21.5
SC	601	20.5	18.5
TF	563	19.8	19.7
HC	545	22.7	20.2
ELF	445	28.6	24.9
DF	342	30.0	32.0
EDF	285	37.8	38.9
DEDF	238	44.0	46.5

Editor's Note: The following abstracts are from papers given at the 1950 National Technical Conference, Illuminating Engineering Society. While the subject matter does not deal directly with glass technology, it is of interest to glass technologists as it shows the end use of some recent developments in the field of glass.

New Glass Developments in the Field of Illumination. By Dr. W. W. Shaver, Corning Glass Works, Corning, New York.

Recent developments in glass have produced two new types with interesting properties in the lighting field.

The 96 per cent silica glasses have unusual heat resistance, both as to heat shock and softening temperatures. These glasses are made by a unique process which has been called the only new development in glassmaking since glass melting began. Alkali borosilicate glasses melted and formed by conventional methods to the desired but oversized shape are then subjected to a heat treatment followed by immersion in a dilute acid bath for a period of time depending upon the wall thickness. In the acid bath, the soluble materials in the glass are leached out, leaving a porous structure of 96 per cent silica composition, with the product having the same size and shape, but weighing one-third less. In the final step in the process, the porous glass article is heated to a high temperature causing a predetermined linear shrinkage of some 14 per cent in all dimensions. This final 96 per cent silica glass has properties comparable to those of fused silica with the advantage that it can be made into products by conventional glass-forming methods which are entirely impractical for fused silica on account of its high working temperature. Suitable graded seals for bridging the gap between the 96 per cent silica glasses and tungsten, molybdenum, or special metal alloys have been developed and are commercially available.

These high-silica glasses have interesting possibilities in many fields. One type with high ultraviolet transmission and low solarization rate is being used as an envelope for germicidal lamps. With the unusual heat resisting properties of these glasses, it is possible to design high wattage incandescent lamps with much smaller envelopes than previously have been used. Cover glasses and lenses can be made in these glasses for use with light sources of extremely high wattage where temperatures are such as to prohibit the use of the well-known heat-resisting glasses.

The second type of glass having applications in the

(*Continued on page* 654)

GOVERNMENT SHOWS MOVIES OF AUTOMATIC BOTTLE MAKING IN CUSTOMS TRIAL

The U. S. Customs Court in New York last month heard "new evidence" submitted by the Government in a renewal of the years-old controversy over the proper duty to be paid on certain types of toiletries bottles.

Yardley and Company, Ltd., had filed suit to force entry of English bottles at the lower rate provided for bottles "produced by automatic machine", basing its claim on the disposition of the well-known Griffon case (THE GLASS INDUSTRY, April 1949, page 211). The Government has contended that it has new proof that the toiletries bottles are *not* made automatically, thereby excluding them from the special privileges of machine-made bottles.

When the Yardley case came to trial on November 6, the Yardley attorneys introduced the evidence of the Griffon case and rested. The Government, as its new evidence, showed two movie films. One demonstrated the operation of the Hartford I-S bottle making machine, showing the automatic bottle making process as it is conceived in the United States. The other film showed the operation of a Schiller type machine, which is the method by which the imported Yardley bottles are made. It was expected that the difference would demonstrate to the court the differences between automatic and the Schiller (semi-automatic) type of bottle making.

In addition to the presentation of the film, as witnesses for the Government, testimony was offered by Carl L. Hilgenberg, Vice President and Secretary; William Heinnger, Assistant Plant Manager, and George Minnick, Foreman in charge of the hardware department, all of the Carr-Lowrey Glass Company.

Mr. Hilgenberg testified that he had gone to Germany in 1931 to observe German methods of producing cosmetic and toiletry ware and, at that time, had seen the Schiller machine in operation. Mr. Hilgenberg also stated that in 1936 his company had bought a Schiller machine and today is using a modification of this machine which was built in the Carr-Lowrey plant. This modified version of the Schiller machine is similar to the original insofar as the hand operations are concerned. Hartford I-S machines are also used in the Carr-Lowrey plant for making cosmetic and toiletry ware.

Mr. Heinnger testified to the features of the Hartford I-S that made it an automatic operation. Mr. Minnick testified as to the operation of the Schiller type machine as used in his hardware department. He also exhibited neck rings and finishing and parison molds to show how these had to be manually operated in making ware on the Schiller type machine.

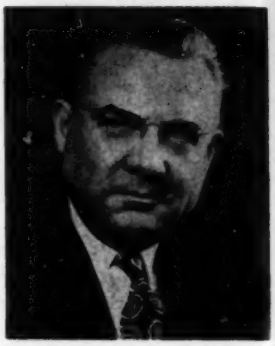
Anthony Simonetti, of the United States Customs Service, testified that he had gone to Europe in the summer of 1949 and had observed glassmaking practices there. These practices, it was observed, were the same as shown in the movie film of the Schiller type machine.

The court gave the litigants 30 days to file briefs.

• The Department of Industrial Engineering, Columbia University, will conduct its Second Annual Conference on Industrial Research during the week of June 11 through 15, 1951. The emphasis at the Conference will be on the selection, training, and administration of research personnel.

RAYMOND SZYMANOWITZ ELECTED DIRECTOR OF ACHESON COLLOIDS LTD.

Raymond Szymanowitz has been elected a Director of Acheson Colloids Limited, of London, England, at the recent Annual Stockholders' Meeting, Acheson Colloids Ltd. is the British affiliate of Acheson Colloids Corporation, Port Huron, Michigan.



Mr. Szymanowitz has been with Acheson Colloids Corporation since 1924 and has been Technical Director of the firm since 1938. He received his Bachelor of Science degree from Cooper Union in 1922 and was a part-time instructor in the Department of Chemical Engineering at Cooper Union from 1928 to 1941.

Mr. Szymanowitz has been chemist, research assistant, technical director, inventor, and author at one time or another for the past thirty years. He has held technical positions with General Motors Corporation and the Bell Telephone Laboratories, and in 1936 he patented a matrix coating composition for use in stereotyping operations. His articles on colloidal graphite have appeared in numerous technical and scientific periodicals.

LYNCH EXPANSION

George W. Lathrop & Sons Co., Toledo, has been awarded the contract for construction of a $250,000 addition to the Lynch Corporation's Anderson, Ind., plant, M. H. Pendergast, Lynch President, has announced.

The addition will double capacity of the plant's grey iron foundry and provide space for new boilers and generating equipment and expanded facilities for cleaning of castings, Mr. Pendergast said.

METRO EXPANDS JERSEY CITY PLANT

Ground has been broken for an 80,000-sq.-ft. addition to the Metro Glass Bottle Co. plant in Jersey City, N. J., reports the Joseph J. Garibaldi Organization.

The new one-story building, designed by George Siegler, is expected to be completed next spring.

THE COVER

The cutting wheel illustrated on the cover is one of a battery of such wheels used with B&L's newly designed spherical generators. The machines are employed to diamond-mill convex and concave surfaces of pressings, to mill counter-sinks, and to remove "buttons" after fusing. Diamond-charged tools produce the necessary abrasive action. The process replaces manual and spindle grinding operations, orthodox techniques for these phases of lens production. Grinding which formerly took hours is now done in seconds. Of major importance, the equipment has untold value in quality and precision control and in increased production.

CURRENT STATISTICAL POSITION OF GLASS

Employment and payrolls: During September 1950, employment in the glass industry was 118,300. Compared with the previous month's 121,800 employees, a drop of about 3½ per cent was indicated for September. During September 1949, there had been 107,100 persons employed, or 10 per cent below September this year.

Payrolls during the month of September 1950 were reported at a preliminary $31,629,473. This is a little more than 1½ per cent above the adjusted payrolls of $31,076,874 reported for August. During September 1949, payrolls had been $26,008,164.

Glass container production for October 1950, based on figures released by the Bureau of Census, gave an indication of a "back to normal" availability of soda ash. During that month manufacturers produced 10,611,617 gross of glass containers. This is 22 per cent more than September's 8,672,525 gross. During October 1949, production had been 8,283,420 gross, which is 28 per cent less than for October this year. Thus far in 1950 glass container manufacturers have produced 87,691,436 gross. This is a little over 14½ per cent more than the 76,416,861 gross produced at the close of the corresponding period in 1949.

Shipments of glass containers for October, however, dropped for the first time in several months to reach 9,212,080 gross. This represents a decrease of 13 per cent from the previous month's 10,617,050 gross shipments. During October 1949, manufacturers shipped 7,945,312 gross, or close to 16 per cent less than during October 1950. At the close of the January-October 1950 period, shipments of glass containers have reached 90,105,205 gross. Compared with shipments of 75,947,018 gross at the end of the 10-month period in 1949, it is indicated that 1950 shipments are running 18½ per cent ahead of 1949.

Stocks on hand at the end of October indicate a return to normalcy and manufacturers have built up their stocks to 6,123,066 gross. At the close of September there were 4,865,187 gross on hand. Thus, at the end of October, stocks had increased close to 26 per cent. During October 1949, stocks were 8,601,979 gross.

Automatic tumbler production for October 1950 jumped 18 per cent to reach 6,994,350 dozens, as compared with the previous month's production of 5,925,365 dozens. During October 1949, production had been 5,521,215 dozens. Shipments, however, dropped to 5,498,188 dozens. This is close to 9½ per cent below the previous month's shipments of 6,069,959 dozens. Shipments during October 1949 were 5,436,365 dozens. Stocks of automatic tumblers were 8,876,870 dozens. This is a little more than 9 per cent above stocks of 8,118,195 dozens on hand at the close of September. At the close of October 1949, stocks were 7,676,420 dozens.

Table, kitchen, and household glassware: Manufacturers' sales of machine-made table, kitchen, and household glassware for October 1950 rose 14½ per cent to reach 3,846,035 dozens. This is above September sales of 3,355,814 dozens. During October 1949, sales were 3,801,002 dozens. During the twelve months of November 1949 through October 1950, manufacturers' sales have reached a total of 39,165,621. This is only slightly higher than the 39,004,211 dozens sold at the close of the corresponding months ended October 1949.

GLASS CONTAINER SHIPMENTS

(All figures in Gross)

	October 1950
Narrow Neck Containers	
Foods	953,476
Medicinal & Health Supplies	1,244,892
Chemicals, Household & Industrial	657,007
Beverages, Returnable	325,329
Beverages, Non-returnable	15,056
Beer, Returnable	291,654
Beer, Non-returnable	271,820
Liquors	917,850
Wines	357,445
Toiletries & Cosmetics	562,152
Sub-total (Narrow)	5,596,681
Wide Mouth Containers	
Foods	2,367,059
Dairy Products	353,884
Home Canning	*
Medicinal & Health Supplies	287,646
Chemicals, Household & Industrial	121,728
Toiletries & Cosmetics	132,813
Packers' Tumblers	106,780
Sub-total (Wide)	3,369,910
Total Domestic	8,966,591
Export Shipments	245,489
Total Shipments	9,212,080

*This figure is included with Wide Mouth, Foods.

GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in Gross)

		Production October 1950	Stocks October 1950
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck	3,949,306	2,202,090
	Wide Mouth	3,546,220	1,910,628
Dairy Products		397,260	231,394
Home Canning		*	*
Beverages, Returnable		418,102	530,931
Beverages, Non-returnable			21,114
Beer, Returnable		357,541	173,225
Beer, Non-returnable		276,322	215,904
Liquors		1,111,751	534,422
Wines		424,708	220,402
Packers' Tumblers		130,407	82,956
Total		10,611,617	6,123,066

*This figure is included with Wide Mouth, Foods.

PENNSALT MOVES CHICAGO OFFICE

Pennsylvania Salt Manufacturing Company has announced the removal of its district sales office to Suite 1216 Builders Building, 228 North LaSalle Street, Chicago.

The new office will be under the direction of George D. Grogan, District Sales Manager for the company's Heavy Chemicals Department, and John C. Hampson, District Sales Manager for the Special Chemicals Department.

NEW EQUIPMENT AND SUPPLIES

ROTARY BATCH MIXER

Worthington Pump and Machinery Corporation, Dunellen, New Jersey, has recently announced a batch mixer said to offer maximum protection from dust hazards. To eliminate dust during discharge of batch, a dustproof housing enclosing the discharge chute is furnished.

The sealing joint packing on discharge side of drum revolves with the drum. The discharge housing portion of the seal remains stationary. To eliminate dust during the mixing period, a sealing disc is furnished attached to the inner side of the discharge chute, completely closing discharge opening while mixing. The spring and bearing on the outside of the sealing disc keep the disc centered at all times. A simple adjustment furnished allows "take-up" to provide for wear.

The sealing joint revolves with the drum on the charging side. Packing is kept in place by a retaining ring accurately bolted to true center of the drum with adjustment provision for keeping the packing tight.

The units embody the Ransome mixing action where the mixture goes up both sides, falls in two fanlike formations to the bottom, is swished from side to side, carried up again, and the operation repeated. When mixed, the material is discharged leaving the drum completely clean of all material.

NEW STRIP-CHART ELECTRONIC INSTRUMENTS

The Bristol Company, Waterbury 20, Conn., has announced the development of a new line of strip-chart electronic instruments, designated as the Series 500 Strip-Chart Dynamaster Electronic Instruments. The Strip-Chart Dynamaster is a high-speed, self-balancing, a-c bridge designed for measurement of temperature, resistance, conductivity, strain, position, inductance, pressure, force, or any other variable which can be measured in terms of impedance.

The measured variable is recorded on a chart 11¼ inches wide and indicated on a large scale which is legible at a distance. In addition to the single record model, instruments are available for as many as 16 different records on the same chart. Models are offered for full-scale pen travel in 7 records, 3 seconds, and 2/3 seconds, with a full range of standard chart speeds from 1 inch per hour to 120 inches per minute.

Supplementing the recording instruments, Bristol also announced a complete line of Strip-Chart Dynamaster Automatic Controllers, including both electric-operated types and Free-Vane pneumatic types.

G-E REDESIGNED LINE OF THERMOCOUPLE VACUUM GAGES

General Electric Company, Meter and Instrument Divisions, Schenectady, New York, has announced a redesigned line of thermocouple vacuum gages for industrial, laboratory, and other applications where vacuum must be accurately measured.

Included in the line are a 115-volt, a-c, portable thermocouple vacuum gage, and types for both rack and panel mounting. All but the rack-mounted type have been designed to operate either from 115-volt a-c or from No. 2 flashlight batteries.

Usable on either glass or metal vacuum systems, the gages give a continuous indication of pressure and respond almost instantly to pressure changes. Pressure can be read directly from a scale calibrated from 0-200 microns. In the 1-100 micron range, the instruments are accurate within 10 per cent of the reading or 1 micron, whichever is greater.

The gage is connected to the gage tube electrically. Hence, it may be disconnected from the tube without disturbing the vacuum system. The gage tube may be interchanged without the need for recalibrating the indicating instruments. The vacuum-gage tube is built to withstand damage if accidentally operated at atmospheric pressure.

CATALOGS RECEIVED

The Chas. Taylor Sons Company, Cincinnati, Ohio, has announced the publication of its Bulletin Number 314 devoted to Taylor Sillimanite Super-Refractory Cements.

The bulletin illustrates and discusses very fully the firm's product, presenting interesting pictorial illustration. The booklet opens with a general discussion, followed by information on slag resistance, workability, available types, application to the steel industry, the blast furnace, the glass industry, and closes with general precautions in the storing of the product. Also included is a brief section devoted to Heat-Setting vs. Air-Setting Cements and an interesting section devoted to the importance of low shrinkage which illustrates in color the shrinkage of some cements.

Burrell Corporation, 2223 Fifth Avenue, Pittsburgh 19, Pa., has issued two new booklets, one devoted to the International dual-purpose laboratory centrifuge and the other devoted to Castaloy laboratory appliances.

The first bulletin illustrates and describes the International clinical and chemical models, with cut-away illustration. The clinical model gives the user both an analytical and a clarifying centrifuge in one machine and a rheostat mounted in the base provides seven steps of speed control and an off point. The chemical model is especially suited to the filtration of crystal or pulp suspensions for experimental work or preliminary to larger scale operations.

The second bulletin discusses the features of Castaloy laboratory appliances and lists and illustrates the various appliances, giving descriptive material and prices.

Cambridge Wire Cloth Company, Cambridge, Maryland, is distributing an interestingly composed folder, Bulletin No. 102, devoted to its woven wire conveyor belts.

Presented in the form of a blue print, the folder discusses the part played by the Cambridge aluminum conveyor belt in reducing rejects in glass plants. Also covered is the withstanding of the Cambridge Gratex belt to continuous sand blasting and operation under Arctic conditions. A method of cutting manual handling costs in half while boosting output is also discussed.

Barrett-Cravens Company, 4609 S. Western Blvd., Chicago 9, Illinois, is distributing Bulletin P-476, entitled "Designed for Pallets" which contains practical data on pallet design, illustrated with working drawings. Four pages are devoted to palletized carloading, with drawings showing a number of space-saving arrangements.

The 16-page bulletin presents Barrett pallet systems, employing hand and electrically operated lift trucks for single or double faced pallets. Illustrations show how a wide variety of materials and products are moved, stored, or shipped with the pallet system.

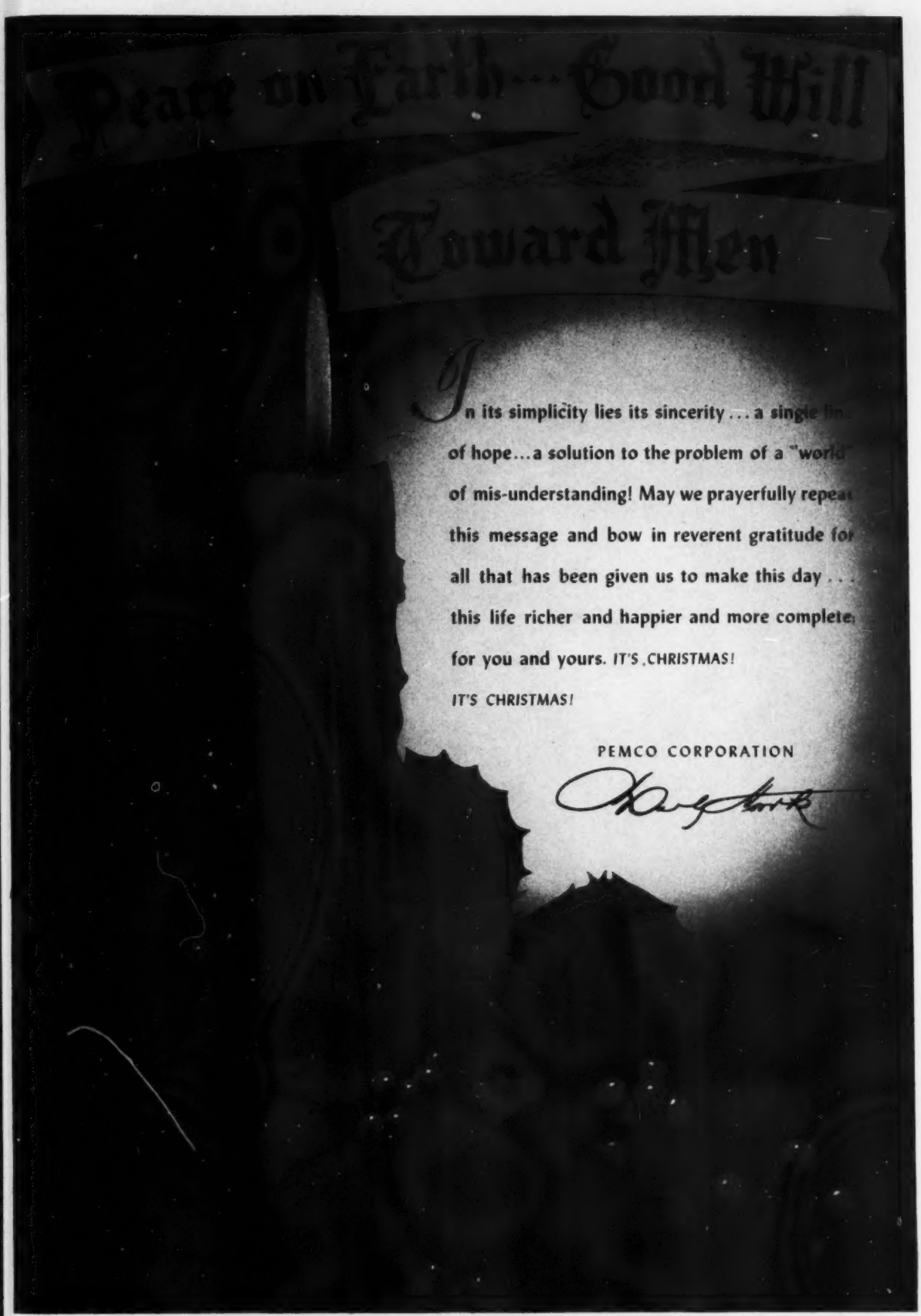
Wheelco Instruments Company, 847 W. Harrison Street, Chicago 7, Illinois, has just released a new condensed catalog illustrating and briefly describing a selection of typical Wheelco indicators, controllers, and combustion safeguards.

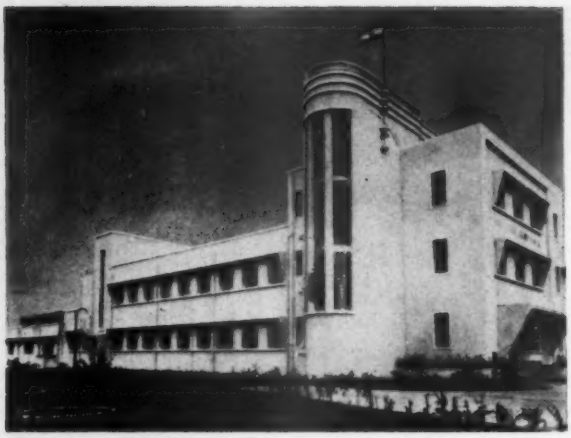
An accompanying four-page price list contains the listing, description, and current price applying to nearly all of the standard instruments manufactured by the firm.

Lyon-Raymond Corporation, 15278 Madison Street, Greene, New York, has issued new literature, Bulletin 222, describing its heavy duty hand pallet trucks in capacities of 4000 lbs. and 6000 lbs.

The features of these products are well described and illustrated. Actual "on the job" applications show just how the truck is used in confined areas and in conjunction with power operated models. Complete specifications are listed for both models.

Towmotor Corporation, Literature Department, 1226 East 152 Street, Cleveland 10, Ohio, has made available a new Towmotor Accessory Data Sheet covering the details of a new revolving carriage. The sheet illustrates and describes the revolving carriages and gives data concerning dimensions and capacities.


Peace on Earth---Good Will
Toward Men
In its simplicity lies its sincerity ... a single line
of hope ... a solution to the problem of a "world"
of mis-understanding! May we prayerfully repeat
this message and bow in reverent gratitude for
all that has been given us to make this day ...
this life richer and happier and more complete
for you and yours. IT'S CHRISTMAS!
IT'S CHRISTMAS!
PEMCO CORPORATION



RESEARCH INSTITUTE IS DEDICATED IN INDIA

The official opening of the Central Glass and Ceramic Research Institute of India at Calcutta by the Honorable Dr. B. C. Roy, Chief Minister of the Government of West Bengal, brought to that country the answer to a long-felt and urgent need for the establishment of such an institution. This is the fourth laboratory to be established by the Council of Scientific and Industrial Research, the other three being the National Chemical Laboratory at Poona, the National Physical Laboratory at Delhi, and the Fuel Research Institute at Dhanbad.

The laboratory is located in Jadavpur, a southern suburb of Calcutta, and occupies a total floor area of about 45,700 sq. ft. The Institute is a carefully designed and well-equipped laboratory providing facilities for team work and for specialized research in glass and ceramics. Researches on colored glass, sintered glass, and foam glass are already in progress. Glass is used extensively in the construction of the laboratory for both functional and decorative purposes.

Apart from fundamental research, an importnat function of the Institute will be to render technical help to industry in the improvement of the quality of products and to induce industry, by demonstrating the benefits of scientific methods, to utilize and adopt improved techniques in works operations. Standardization and improvement in the quality of raw materials is an essential requirement for quality production. In the course of time, the Institute will encourage factories to send their workers to make use of its facilities for short periods of time so that they may be trained in the use of scientific methods and instruments, with a view to the ultimate application of the knowledge in manufacture.

An important function of the Institute will be the collection of data and the dissemination of technical information. In fulfilment of this function, the Institute maintains a library for the use of its own workers and for the workers of other institutions and industry.

Officers of the Institute are Atma Ram, Joint Director; V. P. Varshney, Assistant Director; K. D. Sharma, J. C. Banerjee, and S. N. Prasad, Senior Scientific Officers; A. K. Dastidar, Engineer; B. F. J. Rao and P. Roy, Junior Scientific Officers; O. P. Mullick and S. B. Roy, Senior Scientific Assistants; and S. C. Majumdar and V. K. Vaish, Junior Scientific Assistants.

MELTING *and* FINING

BORAX... a small addition of B_2O_3 to the glass batch, if properly substituted for a part of one or more of the major constituents, will improve the melting temperature and fining rate which should effect economies in fuel and refractory life.

Our representatives are prepared to discuss all the special advantages of B_2O_3 in glass.

PACIFIC COAST BORAX CO.

Division of Borax Consolidated, Limited

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Here Are The World's Sights and Sounds

which GAS helps bring into your home

DISTANCE IS NO OBSTACLE to the engineers who work with scenes and sounds. Miles are merely a challenge calling for improved methods and means of transmission. Here, in the development of these modern systems of communications, Gas plays one of its major roles as a processing fuel in glass and ceramic manufacturing.

IN RADIO AND TELEVISION the versatility of Gas is well demonstrated. The familiar tubes in receiving sets, the picture-screens of television, the giant tubes at transmitter stations—these are products of Gas-fired glass melting tanks, forming molds, stem machines, and annealing ovens.

FOR TELEPHONE AND CABLE manufacturing the use of Gas is so common that it's frequently overlooked. Glass and ceramic insulators, battery jars, signal lamps, ceramic dial discs, are just a few of the products in which Gas is used for efficient and precise heat-processing.

PHOTOGRAPHY AND PRINTING, two other methods of bringing you the world's sights and sounds, have at least one common bond. In the manufacture of cameras and accessories, and in the printing of newspapers and magazines, Gas has always been an important factor—essential in glass lens manufacturing, in ceramic projection-arc production and in myriad related ceramic and glass objects.

FOR ALL GLASS AND CERAMIC PROCESSING the advantages of Gas and modern Gas Equipment are readily demonstrated. There's always a way to do production-line heating simply and economically with Gas —your Gas Company Representative can be of real assistance, call him today.

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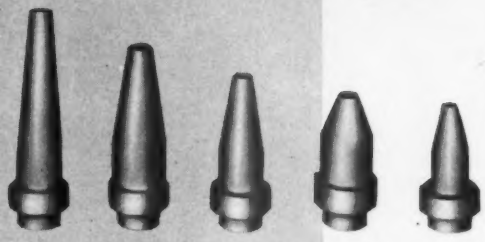
MORE AND MORE... THE TREND IS TO GAS

GUNITE

PLUNGERS



Standard plungers in all sizes from MG1 to MG10. Easily machined and polished to a mirror finish.

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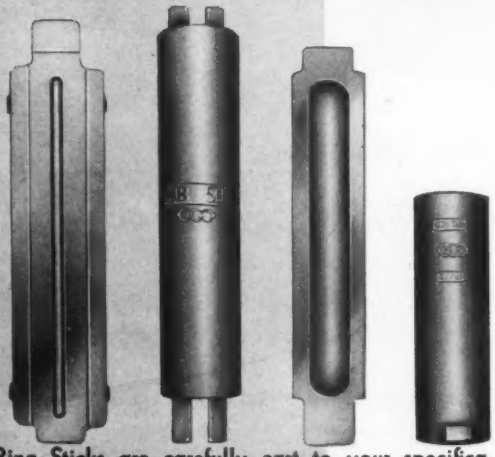

Ring Sticks are carefully cast to your specifications from your own patterns. Readily machinable.

BAR STOCK

Round bars in standard 14 inch lengths. 1/2 inch diameter to 5 inch diameter by 1/4 inch increments.

ALL GUNITE castings are made of Gunite Metal suitably alloyed to provide the ideal glass house material. Gunite Metal is easily machined and readily polished to a mirror finish. Gunite Metal has maximum resistance to heat checking under the severe conditions imposed by glass making operations. You'll get superior service from GUNITE.

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ESTABLISHED IN 1854

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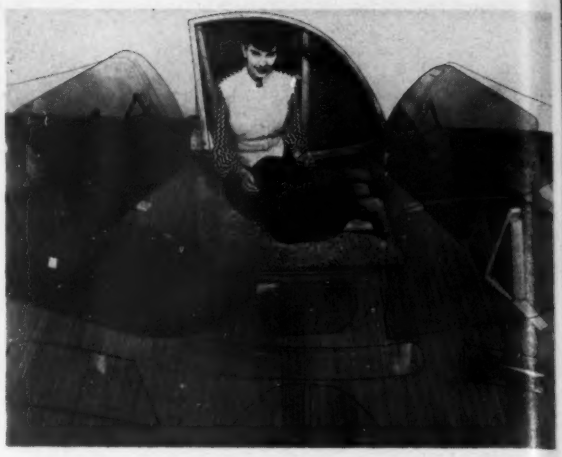


DEVELOPMENT OF NEW GLASS BY PPG MAKES FUTURISTIC DREAM CAR POSSIBLE

In an announcemnt made by Dr. J. Hervey Sherts, Product Development Director of Pittsburgh Plate Glass Company, he discussed the role glass plays in the designers' futuristic dream car, and the practicability of such a car due to technological advances in glass manufacture.

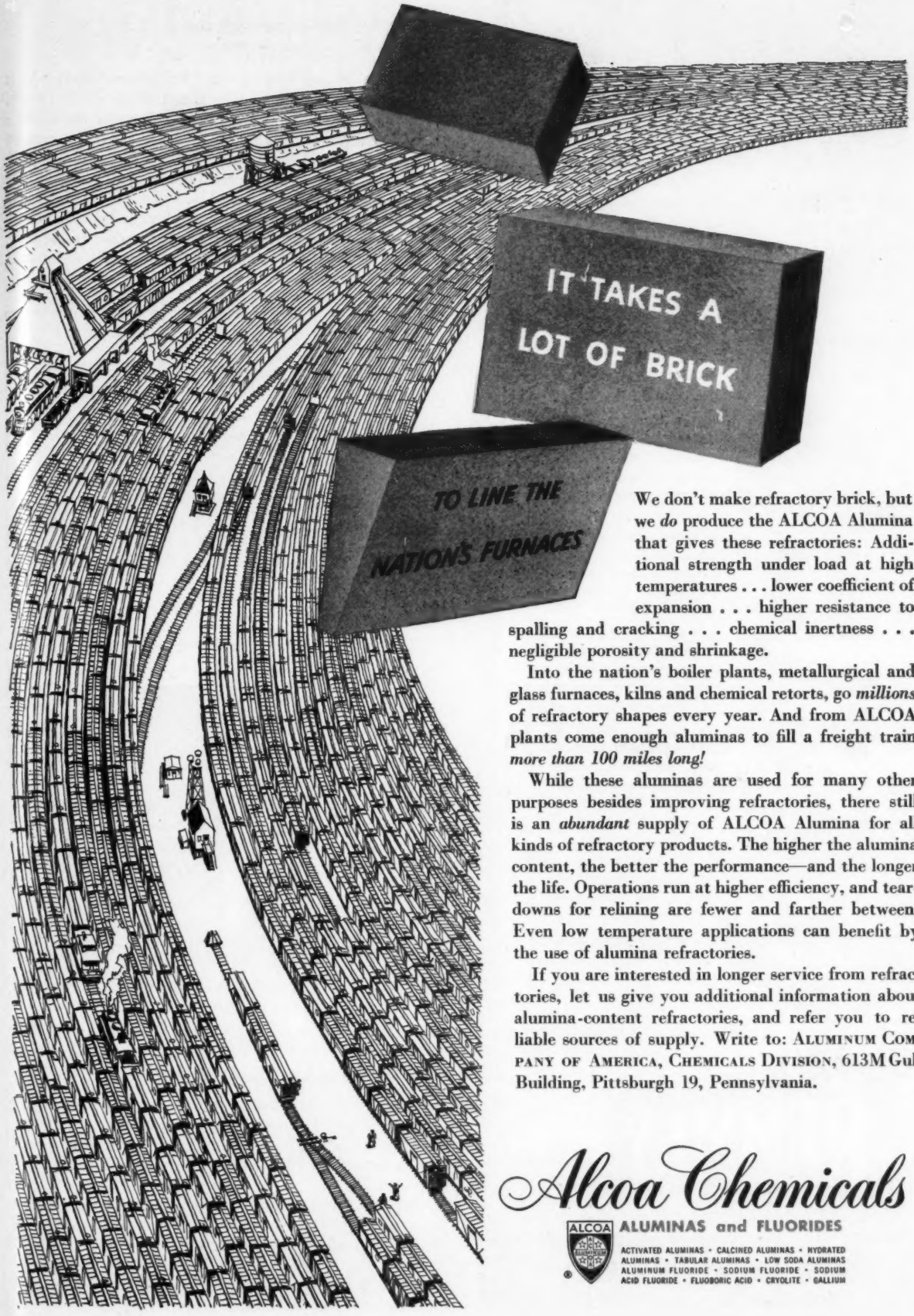
Pittsburgh Plate technologists have been working since 1929, Dr. Sherts stated, to impart to glass the structural qualities, impact resistance, glare reducing and heat absorbing values in forms and shapes desirable for automotive construction while still maintaining the strictly specified optical properties for automobile glazing. He went on, "As a result, we are now equipped to put a glass band around your car, give it a glass roof, or in fact enclose it in glass, except for supporting members.

"To list a few of these futuristic automotive glasses there is, for instance, the graduated glare-reducing glass which we first introduced commercially last year in the Greyhound Sceni-Cruiser bus. Stained a deep bluish-green at the top to screen out the sun's glare and unwanted heat rays, it eliminated the need for window shades. Density is gradually decreased to permit full vision of the passing landscape to eye level where it has complete optical clarity.

"Heat tempered automotive glasses that we are manufacturing in myriad shapes and bends have four to five times the impact resistance of ordinary glass of the same thickness yet retain crystal clarity for good optics.

"Other glasses we can now provide will withstand the impact of a four-pound brick traveling sixty miles an hour or a 30-pound boulder dropped eight feet; glasses that will reduce the sun's infrared or heat ray transmission to less than 5%; and others that will insulate the interior car against high or low outside temperatures to the same degree as an 8" brick wall. In addition to their wide range of special functions, all these new automotive glasses have the properties of standard laminated safety glass in case of an accident and, in addition, can be offset at the edges to permit flush mounting for aeronamic as well as asthetic reasons.

• Dr. B. W. King has joined the staff of Battelle Memorial Institute where he is engaged in research on ceramic problems. Dr. King was formerly in charge of ceramic research at The Harshaw Chemical Company.



We don't make refractory brick, but we *do* produce the ALCOA Alumina that gives these refractories: Additional strength under load at high temperatures . . . lower coefficient of expansion . . . higher resistance to spalling and cracking . . . chemical inertness . . . negligible porosity and shrinkage.

Into the nation's boiler plants, metallurgical and glass furnaces, kilns and chemical retorts, go *millions* of refractory shapes every year. And from ALCOA plants come enough aluminas to fill a freight train *more than 100 miles long!*

While these aluminas are used for many other purposes besides improving refractories, there still is an *abundant* supply of ALCOA Alumina for all kinds of refractory products. The higher the alumina content, the better the performance—and the longer the life. Operations run at higher efficiency, and teardowns for relining are fewer and farther between. Even low temperature applications can benefit by the use of alumina refractories.

If you are interested in longer service from refractories, let us give you additional information about alumina-content refractories, and refer you to reliable sources of supply. Write to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 613M Gulf Building, Pittsburgh 19, Pennsylvania.

Alcoa Chemicals

ALCOA ALUMINAS and FLUORIDES

ACTIVATED ALUMINAS • CALCINED ALUMINAS • HYDRATED ALUMINAS • TABULAR ALUMINAS • LOW SODA ALUMINAS ALUMINUM FLUORIDE • SODIUM FLUORIDE • SODIUM ACID FLUORIDE • FLUOBORIC ACID • CRYOLITE • GALLIUM

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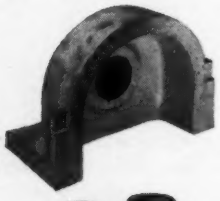
FOR
Efficient Production

CRYSTALITE (mullite-bonded mullite) glass feeder parts are rigidly controlled through each production phase for close tolerance, dimension accuracy as well as uniform quality. Time wasting adjustments are eliminated.

For better, more efficient production . . . elect **REMMEY CRYSTALITE,** feeder parts to do the job.



BONUS-BUILDING SPOUTS
Long-lived, firm closure at tube seat . . . close-tolerance machined for uniformly accurate location in feeder.

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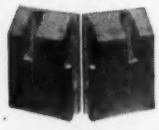
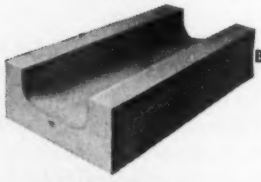
High refractoriness and erosion resistance assure enduring firm closure at tube seat . . . and thorough agitation.

BONUS-BUILDING PLUNGERS
Retain shape longer for continued, more accurate control of glass gob.

BONUS-BUILDING ORIFICE RINGS—Retain shape and size for longer runs without costly replacement shutdowns.



BONUS-BUILDING BURNER BLOCK—Accuracy of dimension for quick, hairline matching to burners.



BONUS-BUILDING CHANNELS
Uniformity, accuracy, and structural quality combine for longer productive life.

REMMEY

Dependable Refractories

RICHARD C. REMMEY SON CO.

Philadelphia 37 • Pennsylvania

CONTAINER COMPOSITIONS . . .
(*Continued from page 626*)

found in 91 per cent of the 1949 glasses analyzed. It appears most commonly in the 0.02 to 0.3% ranges, showing little change from 1948, although the number of glasses found to contain this element has increased 15 per cent in the last year.

Sulfate, Fig. 8, in appreciable amounts, is found in all the flint and green glasses. The 1949 percentages range from 0.8 to 0.38% and average 0.24%. These figures are almost identical with those found in the past. The value of a few tenths per cent is well recognized as an aid in fining.

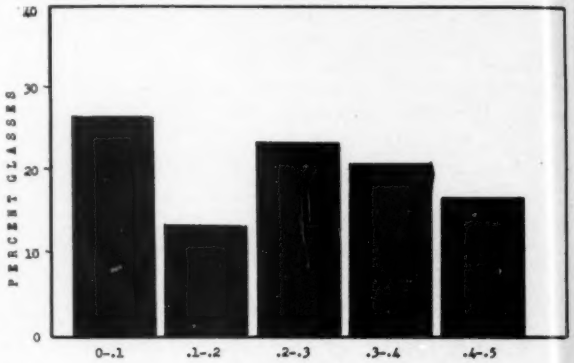


Fig. 7

Fig. 8

FIBERGLAS BIBLIOGRAPHY

The publication of the third edition of the Fiberglas Bibliography, a volume of annotated references to selected articles which have appeared in the nation's press, has been announced by Owens-Corning Fiberglas Corporation.

The bibliography provides a ready reference medium to material published about Fiberglas products. Uses of Fiberglas products documented in the volume include applications in insulated shipping containers, refrigerators, forced warm air furnaces, reinforced hose, wire and cable, ranges and water heaters, aircraft, etc.

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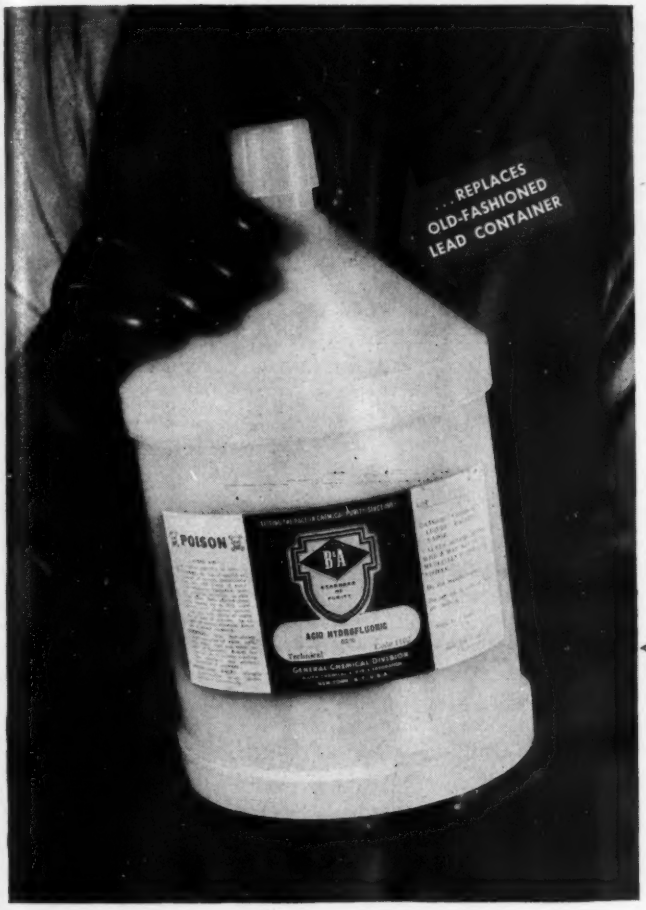
B&A HYDROFLUORIC ACID

Packaged in New Plastic "Jug"



For Industrial Use

B&A pioneered packaging chemicals in plastics when it introduced its famous laboratory Saftepak† for B&A Reagent Hydrofluoric Acid.

Now, B&A offers industry Hydrofluoric Acid and other liquid chemicals in an exclusive new plastic container designed to hold ten pounds of acid. This special container, weighing only 2 pounds, overcomes the difficulties previously experienced with the old-fashioned heavy lead jugs. Review the many advantages outlined! Consider what they can mean to you. Then order your HF requirements from B&A today.

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Note these 8 big special features!

1. **Economical**—Lower tare weight for each 10 pounds of acid purchased.
2. **Stronger . . . Safer**—Bottle molded of shatter-proof plastic. Won't develop dangerous leaks common to lead containers.
3. **Lighter . . . No excess weight**—Two pound "jug" holds 10 pounds of acid. Compare with 17 pound lead container holding same amount.
4. **Easier to handle**—Convenient size and light weight insure ease of lifting and pouring.
5. **Easier to open**—Screw-type plastic cap makes reclosure easy; safeguards against spillage . . . leakage; protects purity. Compare with hard-to-remove rubber stopper on lead container.
6. **Easier to pour**—Special bottle design and pouring lip insure clean, accurate dispensing.
7. **Acid resistant**—Entire unit made of polyethylene: highly resistant to aqueous HF, other acids.
8. **Acid level always visible**—Translucent plastic eliminates guesswork or measuring sticks.

PACKING: Four bottles cell-packed in standard returnable wooden shipping case . . . easy to handle . . . easy to store . . . easy to return. Single bottles available in sturdy wire-bound box.

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SETTING THE PACE IN CHEMICAL PURITY SINCE 1882

* Complete stocks are carried here.

RESEARCH DIGEST . . .

(*Continued from page* 643)

lighting field is the new photosensitive glass in which patterns or pictures can be made right in the glass itself by a photographic process, giving minute detail and various color tints. These glasses are clear, high-quality glasses melted and manufactured by conventional glass-making methods. The production of a pattern or picture in the photosensitive glass medium consists of two parts: exposure and development. Ultraviolet light is used for exposure, with energy in the wavelength range of from 300 to 350 mm. Final development of the picture consists of a heat treatment which includes heating the glass to a temperature somewhat above red heat for a period of 5 to 60 minutes and then cooling it slowly to anneal.

A second photosensitive glass produces a white or tinted opal on exposure and development with many possible lighting applications. Various patterns of louvers or vanes can be developed in this glass in the form of rolled or polished plate. Flat sheets ⅛-inch thick developed with a louvered pattern, such as the egg crate design having approximately ⅛-inch spacing, may be used with various types of light sources to control the distribution of light with a cut-off at an angle of 45 degrees. Such louvered glass, in combination with a good reflector, produces an efficiency of 70 per cent or above.

Recent Developments in High Wattage Tungsten Lamps. By R. G. Slaner, Sylvania Electric Products, Inc., Salem, Mass.

All high-wattage tungsten lamps have been circumscribed by the same factor—heat as it affects the glass bulb and inner mount. The recent introduction of a 96 per cent silica glass suggests that such restrictions may now be greatly modified. The operational limit of this new glass is about 800°C. as compared with the 400°C. of previously used glasses.

An initial investigation has resulted in the tentative standardization of a line of three infrared lamps for use in domestic electric ranges, replacing the conventional sheathed coil surface element. A wattage of 1250 is housed in a bulb of about the same size as the 150-watt PAR-38 hard glass lamp, perhaps the most comparable for thermal shock applications.

The infrared stove lamps are of two-piece construction, fused at maximum diameter. A graded seal forms the major part of the bulb neck in order to bridge the gap between the working temperatures of the new glass (over 1500°C., necessitating a furnace) and borosilicate glasses (under 1000°C., therefore workable under external gas flames). Evaporated gold is used for the reflecting surface.

For electric-range use, the lamp is placed under a top plate of the new glass tinted to a red color. The latter serves as an effective surface on which to place pots and pans, it absorbs 98 per cent or more of the visible energy, and it prevents cooking spillage from reaching the inside of the range. The order of magnitude of operating efficiency, maintenance, and life are about the same as for conventional units; the cost, for the present, somewhat higher. Its advantages, as compared with conventional units, are (1) instant heat, (2) visible indication of heat, (3) more uniform heat, (4) smoother range top, (5) easier cleaning, and (6) higher speed for small quantities of food.

The use of the new glass for domestic ranges does not imply any limit to other infrared uses. A universal-burning industrial infrared lamp could deliver 20 watts per sq. in.; a restricted-burning lamp perhaps up to 30. Since protection from thermal shock is increased by a factor of 8, it is almost fool-proof on this basis. Ice water on a 1250-watt lamp with a surface temperature over 600°C. creates no destructive strain. Universal-burning lamps naturally present special problems if excessive temperatures are allowed to affect the sealing area (borosilicate glass) but the available margin seems ample for effective lamp design.

As important as infrared uses for this new glass, are suggested uses in the lighting field, particularly for outdoor use. A 1000-watt lamp would weigh under a pound and would need no auxiliaries except to protect the electrical contacts against rain or other forms of moisture. The lamp would be both physically and thermally rugged. Possible applications include sports lighting where a minimum initial investment is desired, gasoline service stations, and temporary lighting for outdoor construction. Because lamps of this material are new, these lighting applications are still in the suggestion stage with actual data limited to casual sampling and experimentation.

PITTSBURGH SECTION OF AMERICAN CHEMICAL SOCIETY ANNOUNCES PITTSBURGH AWARD

William A. Hamor, Assistant Director of Mellon Institute, has been named by the Pittsburgh Section of the American Chemical Society to receive its Pittsburgh Award for 1950. The award, a bronze plaque which is granted annually for outstanding service to chemistry, will be presented to Dr. Hamor at a dinner in the University Club of Pittsburgh on December 21.

In a long and productive career, Dr. Hamor has achieved prominence for his noteworthy accomplishments in research management, and for his authorship and editorship of numerous scientific publications.

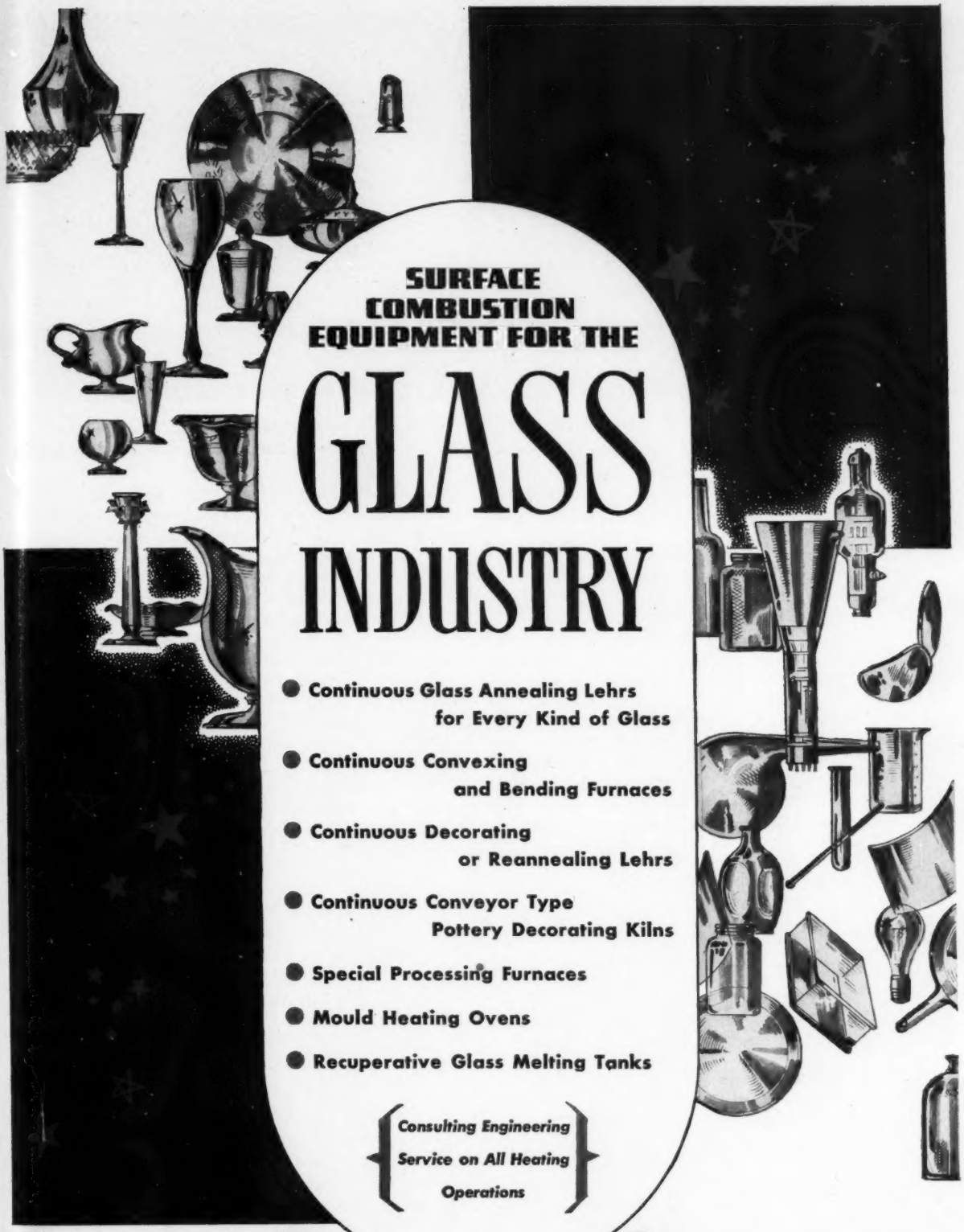
A graduate of the University of Pittsburgh, he has received honorary doctorates from the University of Pittsburgh, Grove City College, the University of Louisville, and the University of Miami. Since 1937, Dr. Hamor has served as Editor of Chemical Monographs for the American Chemical Society.

O-I EARNINGS SHOW INCREASE OF EIGHT MILLION DOLLARS

Owens-Illinois Glass Company net earnings soared to $23,606,334 in the 12-month period ended September 30, an increase of $8,549,750 over the corresponding period a year ago, J. P. Levis, Chairman, reported at a recent meeting of directors.

The net in the latest period was equivalent to $7.72 a share on the 3,056,874 common shares outstanding, against $4.93 in the preceding 12 months, Mr. Levis said.

Directors declared a dividend of $1 a share payable November 15 to stock of record October 30.



SURFACE COMBUSTION EQUIPMENT FOR THE

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- Continuous Glass Annealing Lehrs for Every Kind of Glass
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Consulting Engineering Service on All Heating Operations

SURFACE COMBUSTION CORPORATION

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L-O-F DEVELOPS NEW WINDSHIELD

The teamwork of more than 500 Libbey-Owens-Ford technical and factory personnel, ranging from top research executives to machinists who built special production equipment, was required to develop the new Shaded Windshield.

The problem of how to produce a glass that would combine some form of control for strong sunlight with the retention of good visibility was handed to Dr. George B. Watkins, Director of Research, and Dr. Joseph D. Ryan, Assistant Director in charge of the plastics research section of L-O-F. They carried on from there, recruiting other Libbey-Owens-Ford personnel as the job progressed. Involved in the project were studies in the field of the plastic interlayer used in making laminated safety glass, the composition of the glass itself, and then problems in engineering the machinery for assembling such a unit.

The Shaded Windshield uses E-Z-Eye plate glass which excludes most infrared and ultraviolet rays of sunshine while admitting more than 70 per cent of the visible light in daylight. The glass was the result of chemical changes in the batch and new techniques in making glass.

Bending the glass to provide the single-piece curved windshield with its excellent optical qualities and developing methods for pre-pressing the curved glass and plastic into a sandwich prepared for the laminating process were steps which have taken much engineering. In the Shaded Windshield, the solution for obtaining a delicately tinted band permanently fashioned into the upper portion of the glass finally was worked out in the plastic interlayer. The blue-green band at the top of the windshield, graduated in density so that it permits complete vision and optical clarity at normal eye levels, eliminates the necessity for exterior visors.

Exacting tests are set up for automobile windshields and testing groups in the L-O-F laboratories check all operations on the Shaded Windshield to be sure the new product has the proper optical qualities, impact resistance, and structural strength to meet required standards of performance.

A.C.S. SECTION MEETINGS

The Tennessee Valley Section celebrated its second anniversary on December 1 with an all-day meeting which began early in the day with a trip through the E. I. du Pont de Nemours nylon plant. During the afternoon, technical sessions were held at which the following papers were presented: "High Temperature Metals and Ceramics" by Hans Thurnauer, Director of Research, American Lava Corporation; "Synthetic Minerals" by Robert A. Hatch, Mineralogist, U. S. Bureau of Mines; "Zirconia Refractories" by W. J. Baldwin, Chief, Ceramic Division of Titanium Alloy Mfg. Division of National Lead Company; and "Cover Coat Application Directly on Steel" by M. E. McHardy, Superintendent of the Enamel Plant of Hussman Refrigerator Company. Entertainment and a business meeting followed dinner in the evening.

The January meeting of the Pittsburgh Section of the American Ceramic Society will be held on January 12, 1951 at New Castle, Pa. Following dinner, the group will be entertained at the newly dedicated W. Keith McAfee Laboratory of the Universal-Rundle Corporation.

ACHESON COLLOIDS NAMES PLANT SUPERINTENDENT

Acheson Colloids Corporation has announced the appointment of Frank M. Hall as Plant Superintendent, succeeding Alfred E. Emms, who retired last month.

Mr. Hall was first employed by the Acheson firm in 1919 on production work. In 1934 he was promoted to Foreman and in 1942 he became Assistant Plant Superintendent.

NORTON COMPANY NAMES CHIEF SALES ENGINEER

Robert G. Van Keuren has been appointed Chief Sales Engineer for the Abrasive Division of Norton Company, according to an announcement by Ralph M. Johnson, Vice President in charge of Sales. Mr. Van Keuren succeeds A. Oakleigh Bush, who died in September.

Since 1945, Mr. Van Keuren has been a section head in the Sales Engineering Department with the title of Sales Engineer. He joined the Norton Company in 1923 as a member of the Adjustment Section in the Worcester Sales Department.

Harshaw's newest

WHITE GLASS ENAMEL

- Increased Coverage
- Finer Decorative Detail
- Anti-Slugging

HARSHAW

• Harshaw's white glass enamel, in impartial production runs, has decorated 8% to 35% more bottles per pound of glass enamel than other brands.

Also, sharper decorative lines and smaller letters are made possible with this new white glass enamel for decoration of glassware by the silk screen process.

Another important advantage is its anti-slugging properties. When production is resumed after a slow down or stoppage there is little or no smearing of your product. Harshaw's new white does not have the tendency to "seep thru" the silk screen.

Contact the nearest Harshaw branch office for additional information or quotation.

THE HARSHAW CHEMICAL CO.

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PRECISION THERMOSTAT . . .

(*Continued from page* 637)

secondary of a mutual inductance located in the same arm of the bridge as the variable resistance. In order to use the mutual inductance with furnaces of various inductances, the primary winding is tapped at three points.

The amplifier has a gain of about 6,000 and is of the conventional resistance-capacity coupled type. The thyratron tube employed is the sensitive, four-electrode 3D22. This tube, because of its inert gas content, has a control characteristic which is essentially independent of ambient temperature variations over a wide range. It also has such advantages as high current capacity, small preconduction or gas-leakage currents, low control-grid-to-anode capacitance, and low control-grid current.

In practice, the furnace is first brought to approximately the desired temperature by manipulation of the autotransformer. The variable bridge arm is then set at a value found by experiment to correspond to the temperature desired. During long periods of continuous operation the balancing resistance is usually adjusted at about three-day intervals to compensate for the drift in the resistance of the winding.

In several hundred short quenching experiments at the National Bureau of Standards lasting from 30 minutes to an hour, average temperature variations with the thermostat correspond to 1 or 2 microvolts in a platinum —platinum-rhodium thermocopule ($1\mu V = 0.084$ degree at 1300°C.). Dependability for long experiments was

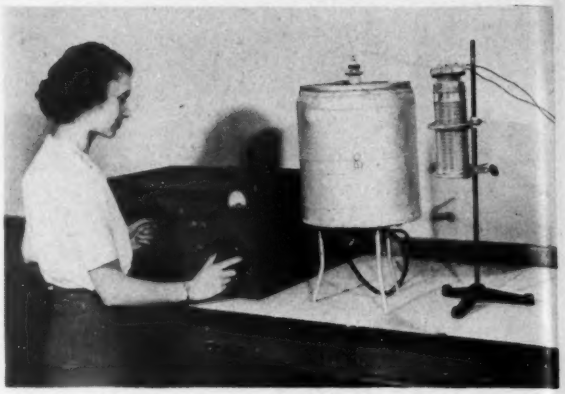

Figure 2. Electric furnace temperatures are maintained constant within a very small range at temperatures above 1000°C. by means of the Bureau's improved thyratron regulator (left).

demonstrated in constant control of a quenching furnace at 1300°C. for more than a month and at 1350°C. for three weeks. The average of 20 consecutive fluctuations occurring over night and during week ends was less than 0.5 degree C.

An advantage in the use of the phase-controlled thyratron is gradual or proportional control as contrasted to on-off control. Over-shooting, which appears with on-off control, is greatly reduced. It is expected that the control circuit developed at the Bureau will find application in the regulation of other furnaces and in baths and

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heaters operating at lower temperatures. Heater elements, such as pure nickel or certain nickel-chromium alloys, which have sufficient change of resistance with temperature in the lower temperature ranges would, of course, be required in the latter applications.

ACHESON COLLOIDS' EXECUTIVE RETIRING

George R. Siegrist, Executive Vice President, Treasurer, and Director of Acheson Colloids Corporation, is retiring because of ill health after thirty years of service.

Mr. Siegrist joined the firm in 1911 and was later transferred to Acheson's European plants in Verviers, Belgium, Novara, Italy, and Epinol, France. Rejoining the company's Port Huron firm in 1920, he was elected Treasurer in 1928 and was appointed Executive Vice President and Director in 1932.

O-I NAMES GLASS CONTAINER EASTERN MERCHANDISING MANAGER

The appointment of Claude W. Thomas, Jr., as Eastern Regional Merchandising Manager of the Glass Container Division of Owens-Illinois Glass Company has been announced by E. A. Hildreth, Manager of the Market Development Department.

Mr. Thomas has been assigned the responsibility of interpreting market development policies for the glass company in the eastern market, and will have his headquarters in the company's New York office. He had been Sales Manager of Modern Food Sales Company for four years prior to his present appointment.

INNIS SPEIDEN ADDS TO TECHNICAL SALES STAFF

J. P. Kesling, for the past five years on the technical sales staff of the Dicalite Corporation, has joined Innis, Speiden & Company, according to an announcement by D. S. Cushman, Vice President in charge of Sales.

Mr. Kesling, who was in the technical service department of the Diversey Corporation for five years, is a chemical engineer from the Case School of Applied Science. He opened and managed the Baltimore office for Dicalite before he was transferred to its New York office for technical sales work.

L-O-F AWARDED DEFENSE ORDERS

Defense orders aggregating $8,455,718 have been awarded Libbey-Owens-Ford Glass Company, it has been announced by John D. Biggers, President.

There were seven basic types of products included in the orders, such as aircraft glazings, periscopes, electrapane, gas mask lenses, signal mirrors, heat-treated glass, and miscellaneous laminated safety glass. More than 532,000 units were included in the orders.

CORNING GLASS NET TRIPLES YEAR AGO

Corning Glass Works reported that its net income for the first three quarters of 1950 was $12,298,352, equal to $4.58 a common share. This compares with net of $4,033,137, or $1.44 a share, in the like period of 1949.

Sales for the latest nine months amounted to $80,334,313, against $52,577,058 a year earlier.

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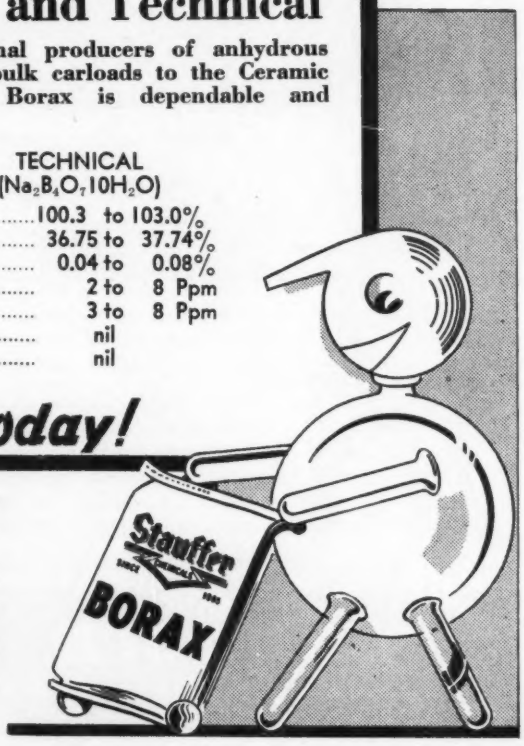
Boron as B_2O_3	68.00 to 68.89%	36.75 to 37.74%
Chlorides as NaCl	0.10 to 0.16%	0.04 to 0.08%
Iron as Fe	30 to 35 Ppm	2 to 8 Ppm
Arsenic as As_2O_2	20 to 40 Ppm	3 to 8 Ppm
Sulphates as Na_2SO_4	0.3 to 0.4%	nil
Carbonates as Na_2CO_3	nil	nil



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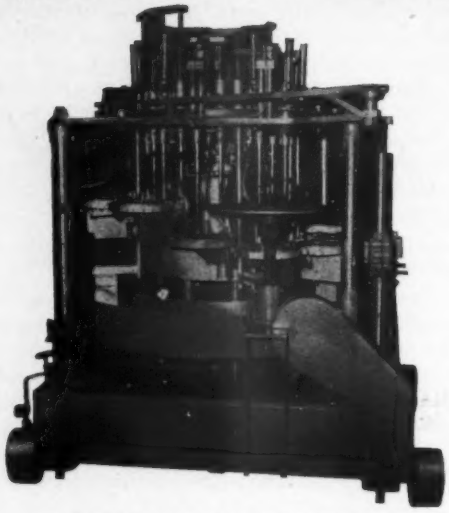

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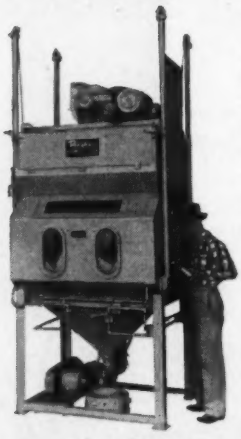

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RUSSIAN TRANSLATIONS . . .
(*Continued from page* 631)

ity of about 0.4, the heat conductivity of foam glass is 0.071 cal./meter.hour.degree C.

The main outlet for foam glass is the refrigerator industry. This requires specific gravity not above 0.35, compression strength not below 25 kg. wt./sq. cm., and absorption of water not above 5%.

SAFETY PROGRAM . . .
(*Continued from page* 636)

experienced, well-trained people, have emergency repair tools in a definite place and handy at all times.

3. Hot repairs: proper working conditions—platforms with guard rails, fans, heat shields, etc., never send a man in where you would not go yourself, use every protective device possible, good supervision.

4. Cold repairs: make a schedule or plan to aid diversion of work and prevent congestion, never allow one group to work over another where things may be dropped, use mechanization wherever possible, maintain good housekeeping at all times.

• Harbison-Walker Refractories Company has announced the appointment of Carl G. Holmes to its Pittsburgh District sales staff. A graduate of Penn State College, Mr. Holmes has had 18 years experience in the sale of insulating and refractory products.

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HENRY W. HESS DIES AFTER LONG ILLNESS

Henry W. Hess, 73, internationally known glass engineer who developed some of the first mechanical devices used in the glass industry, died in Toledo following a long illness. Mr. Hess, associated most of his life with the glass industry as a consulting engineer, chemist, and lecturer, was a native of Toledo.

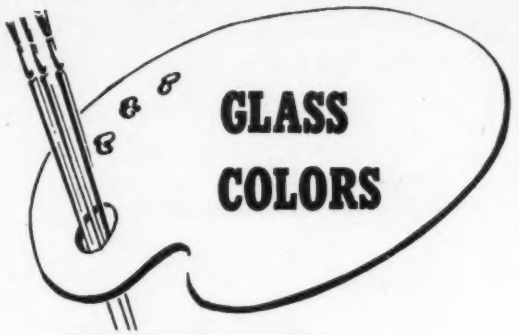
Following his graduation from the University of Michigan in 1899, where he received his bachelor's and master's degrees, Mr. Hess joined the old Toledo Gas, Light & Coal Co. In 1905, he moved to the Libbey Glass Co. as a chemical and development engineer.

During the early part of his career, Mr. Hess pioneered in the technical development of the Westlake bulb machine and the Danner tube machine, two of the first mechanical units used in the manufacture of glass. He also pioneered in the development of automobile glass, having made some of the first automobile glass used by Henry Ford in the early 1920s.

Later he established his own business as consulting engineer, specializing in the ceramics, gas, and fuel.

Mr. Hess also worked in England as a consultant on glass machines for the Libbey Glass Trust at the Osram Co. Because of his extensive knowledge and wide experience in glass work, Mr. Hess served as liasion expert between Libbey and many industrial institutions.

For many years, Mr. Hess wrote a series of weekly articles which ran in the *Glass Workers*, an industrial publication, to promote a better understanding of the technical aspects of the industry among glass workers.



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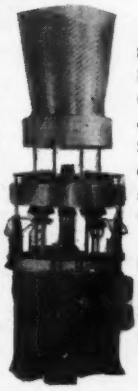

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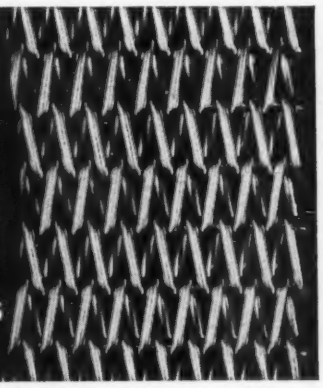

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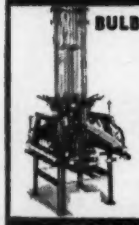

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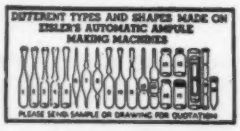
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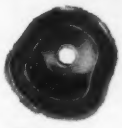

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